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Akbar Nikkhah *

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Review Article

Boosting Concurrent Intakes of Milk, Solid Starter, and Water: The Ultimate Preweaning Calf Management Success Triangle

Akbar Nikkhah [1*] and Masoud Alimirzaei [2]

[1] Chief Highly Distinguished Professor and Nutritional Scientist, National Elites Foundation, Iran

[2] Behroozi Dairy Complex, Tehran, Iran.

***Corresponding Author:** Akbar Nikkhah. Chief Highly Distinguished Professor and Nutritional Scientist, National Elites Foundation, Iran. Email: anikkha@yahoo.com

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Abstract

In this review article, we aimed to explore and discuss interrelationships amongst milk, starter and water intakes and to highlight their cumulative effects on optimizing young calf performance and health. In addition, the unique role of adequate quality water consumption in triggering starter intake and rumen development were discussed. Given that the pre-weaning performance of dairy heifers is associated with their subsequent productivity, efforts have been made to improve calf weight gain in pre- and post-weaning periods. Intensified feeding of whole milk or milk replacers is a nutritional strategy resulting in greater weight gain and feed efficiency in pre-weaning calves. However, depressed starter intake and delayed rumen development are the most prevalent concerns, leading producers to feed calves rather restricted amounts of milk in the pre-weaning period. Recent studies have shown that gradual weaning is a useful method to overcome such negative effects on starter intake and post-weaning performance. Individual differences exist among calves in starter intake behavior and amount. Notably important, calves fed greater amounts of milk and starter simultaneously, grow better and remain healthier than those merely consuming greater milk. To maximize growth performance in both pre- and post-weaning periods, greater starter consumption should be encouraged alongside greater milk intake. Water is essential for stimulating solid feed intake and establishing healthy microbial ecosystem in the rumen. Therefore, the promoted intakes of milk, starter and quality water are all interrelated and should be managed together towards optimal calf health and growth performance, and thus, future productivity and longevity.

Key Words: milk; starter; water; intake; management triangle; calf health

Summary

The aim of this review article was to innovatively emphasize the significance of simultaneous boosting in milk, starter and water intakes for optimal health and growth of pre-weaning calves. Conventional (milk fed at approximately 10% of birth body weigh) and intensified (*ad libitum* access to milk fed at about 20% of body weight) milk feeding systems are the major nutritional strategies adopted to feed young calves worldwide, with each method having its own advocates [1]. The restricted milk feeding method is based on increasing starter intake and early weaning planned to be economical. However, calves on this feeding program do not reach their maximal genetic growth potential and suffer from poor welfare [2]. Moreover, the starter intake, emphasized in such programs, would not support calves' growth until intakes rise enough to meet their maximal growth requirements [3]. As a result, calf growth and perhaps immunity are impaired during the first weeks of life in restricted milk feeding programs. Of practical note, newborn calves respond properly to increased dietary energy and protein supply via greater amounts of milk or milk replacers by increased body lean tissue gain and greater live weight, which are presumably related to their future first lactation performance [4,5]. However, solid feed intake may decrease following the greater milk provision, resulting in sub-optimal rumen development. Nonetheless, it has been reported that gradual reduction of milk allowance promotes growth performance and has no undesirable effects on gastrointestinal development in dairy calves [6]. Accordingly, each of the conventional or intensified methods of milk provision are used by different farmers for different purposes. Referring to recent research [7,8], however, it is obvious that the traditional view into pre-weaning calf rearing should be revised and refined. It is contemplated that enhancing solid feed intake along with greater milk and water consumption is required for maximal calf growth and optimal health and production efficiency. It is necessary to highlight that optimizing and maybe maximizing milk and starter intakes in a parallel way would be an art that would require profound insights into calf nutrition, physiology and behavior.

To better understand the concurrent effects of milk, starter, and water intakes on rumen development and growth performance of pre-weaning

calves, interrelationships amongst these factors should be investigated. An inverse relationship between milk and solid feed intakes has been reported in several studies [9,10]. Nevertheless, it is believed that solid feed intake increases as calves age regardless of milk allowance [2]. With respect to this report and given that calf feed intake rises markedly after weaning, the effects of milk allowance on starter feed intake may be, at least partly, due to weaning age. It appears that extended weaning age may allow calves to improve starter intake and rumen development as well. It has been demonstrated that calves weaned at 56-d of age had greater starter intake and average daily gain than did calves weaned at 42-d of age [11]. Also, calves weaned at 42-d of age exhibited more non-nutritional behaviors than did those weaned at 56-d of age. It seems that milk allowance effects on starter intake may be greater in magnitude in early stages of life. In early ages especially the first three weeks, restricted milk fed calves consumed approximately twice as much starter as did intensified milk fed calves [7].

It is logical that chemical and physical factors controlling feed intake such as higher blood glucose, insulin and also gut-fill related to milk clot formation may induce satiety in calves fed greater amounts of milk [12]. It is important to note that calves have a voracity to eat solid feeds as their age regardless of how much milk they consume [13]. Consequently, providing high quality starter feed accompanied by free access to clean quality water can stimulate greater starter intake in calves on intensified milk feeding programs.

In addition to the physiological relationships between milk and starter intakes, individual calf personality can affect feeding patterns, as well. In a study conducted to determine different individual characteristics among calves, the authors indicated that the age at which the calf starts to eat starter and also total pre-weaning starter intake are the best predictors of weaning age [14]. Slow learner calves were weaned later than exploratory-active calves, indicating that eating more starter as early as possible would result in greater average daily weight gain and smooth transition from liquid to solid feed. Such variations amongst calves seem not to be only because of genetics, as some other factors such as management, dam parity, birth season, and health may be involved in inter-calf differences observed [14]. As such, increasing the number of calves with high capacity for identifying starter feed by improving nutritional management practices can help producers wean their calves safely and efficiently. Also, considering that weight gain and N retention increase in line with milk supply and *ad libitum* access to starter feed [15], optimal management of starter intake would provide an opportunity to reach optimal performance and health in calves under intensified milk feeding systems.

Cereal grains are the main portion of starter feeds. Grain type and amount included in the starter feed and also processing methods used in manufacturing of calf starters may partly explain the different calf growth responses. In a recent review and meta-analysis, greater starter intake was attributed to texturized feeds [16]. As such, it has been reported that supplementing finely ground starter feeds with hay may increase starter intake [16]. In addition to the physical form of the starter diet, it appears that chemical composition of starters impacts on intake and later performance of calves independent of milk feeding program. In a study performed to compare the role of supplying energy and protein from milk replacer or starter, calves with greater vs. lower average daily gain had received greater energy and protein from the starter feed [17]. Interestingly, the greater intake of energy and protein from starter were positively related to their first lactation performance. These results suggest that additional factors beyond milk intake affect growth performance and later milk production of Holstein heifers.

Water is an essential nutrient for young calves because it is necessary for establishing healthy and sustainable microbial ecosystem and triggering solid starter intake. As noted above, the well grown calves are those that are capable to eat more starter and drink more milk and quality water concurrently. The time of water provision to pre-weaned calves is under debate and varies from one farm to another. Some producers believe that calves do not need additional water during the milk feeding period, but this opinion does not seem to hold true in modern dairy farming. Calves receiving additional water apart from the water provided by milk replacer, consumed greater starter feed than those receiving inadequate water [18]. Moreover, improved growth performance, rumen development, and nutrient utilization have been reported for calves receiving quality water from early stages of life [18]. According to the current knowledge, quality water and starter feed must be provided freely to calves under intensified milk feeding programs to help maximize dry matter intake and subsequent growth, health, and productivity.

Conclusion

Maximizing calf weight gain in the pre-weaning period is essential for optimal growth and health and later performance of heifers and herd longevity and economics. As such, the intakes of milk, solid feed, and water should be boosted simultaneously to effectively and timely accomplish the goal. Providing greater amounts of milk and highly palatable and nutrient-rich solid starter alongside quality water provision is greatly recommended. The effects of dry matter supplied by milk and starter are cumulative and would result in improved rumen development, gut integrity, and calf health and growth performance. Consequently, dairy herds' productivity and longevity can improve.

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