Feeding strategies to increase sow colostrum quality and yield

Madie R. Wensley, MS; Mike D. Tokach, PhD; Jason C. Woodworth, PhD; Robert D. Goodband, PhD; Joel M. DeRouchey, PhD; Jordan T. Gebhardt, DVM, PhD

Summary

Effects of nutritional strategies on colostrum quality and yield are variable as influenced by sow colostrum production capacity, parity, farrowing induction protocol, and gestation length. The greatest opportunity to maximize colostrum yield and quality is through proper management of body condition in gestation such that sows are not in a negative energy balance when entering farrowing. Total colostrum fat percentage can be increased through the addition of dietary fat or oil. Colostrum fatty acid composition can also be changed by addition of dietary oil or increased branched chain amino acids. Colostrum protein and immunoglobulins are more challenging to influence.

Keywords: swine, colostrum yield, colostrum quality, feeding strategies, sow nutrition

Received: May 26, 2022
Accepted: November 15, 2022

Resumen - Estrategias de alimentación para aumentar la calidad y el rendimiento del calostro de las cerdas

Los efectos de las estrategias nutricionales sobre la calidad y el rendimiento del calostro son variables, ya que están influenciados por la capacidad de producción de calostro de la cerda, la paridad, el protocolo de inducción al parto, y la duración de la gestación. La mejor oportunidad para maximizar el rendimiento y la calidad del calostro es a través de un manejo adecuado de la condición corporal durante la gestación, para que las cerdas no tengan un balance energético negativo al iniciar el parto. El porcentaje de grasa total del calostro se puede aumentar mediante la adición de grasa o aceite en la dieta. La composición de ácidos grasos del calostro también se puede cambiar mediante la adición de aceite dietético o aumentando los aminoácidos de cadena ramificada. Las proteínas del calostro y las inmunoglobulinas son más difíciles de influir.

Résumé - Stratégies d'alimentation pour augmenter la qualité et la quantité de colostrum chez les truies

Les effets des stratégies d'alimentation sur la qualité et la quantité de colostrum sont variables et influencés par la capacité de production de colostrum par la truie, la parité, le protocole d'induction de la parturition, et la durée de la gestation. La plus grande opportunité de maximiser la quantité et la qualité du colostrum est obtenue par la gestion appropriée de la condition corporelle lors de la gestation afin que les truies ne soient pas en balance énergétique négative lors du début de la parturition. Le pourcentage de gras total du colostrum peut être augmenté par l'ajout de gras ou d'huile alimentaire. La composition en acides gras du colostrum peut également être modifiée par l'ajout d'huile alimentaire ou l'augmentation des acides aminés embranchés. Une influence sur les protéines et les immunoglobuline du colostrum représente un plus grand défi.

Adequate colostrum intake (≥ 250 g is recommended) after birth is essential for piglet survival.[1] As litter sizes have increased in recent years, the demand for colostrum proportionately increases to achieve this desired level of intake. The lactose and fat content of colostrum provides energy, which is needed to maintain piglet body temperature early in life.[2] Additionally, colostrum protein includes immunoglobulins (Ig) for passive immunity, which is necessary for long-term survival.[2] The concentration of these nutrients rapidly changes over the first 24 hours of lactation with the percentage of total solids and protein decreasing over time and the percentage of fat and lactose increasing (Figure 1).[3] The ability for piglets to consume these nutrients is a balance between piglet demand (nursing interval, duration of nursing, and physical capacity to remove colostrum) and the sow's capacity to produce colostrum.[4] This practice tip will cover prefarrowing feeding strategies and potential nutritional interventions that can be used to increase colostrum quality and yield, while also briefly discussing common herd management practices that impact colostrum synthesis.

Prefarrowing feeding strategies that affect colostrum yield

The effect of sow nutrition on colostrum yield is not well understood. Likewise, the multi-faceted nature of colostrum yield and extreme variation between individual sows makes it challenging to consistently detect meaningful differences in the amount and composition of colostrum.[5] Based on the formation of lipid droplets in mammary tissue and increased prolactin levels (due to

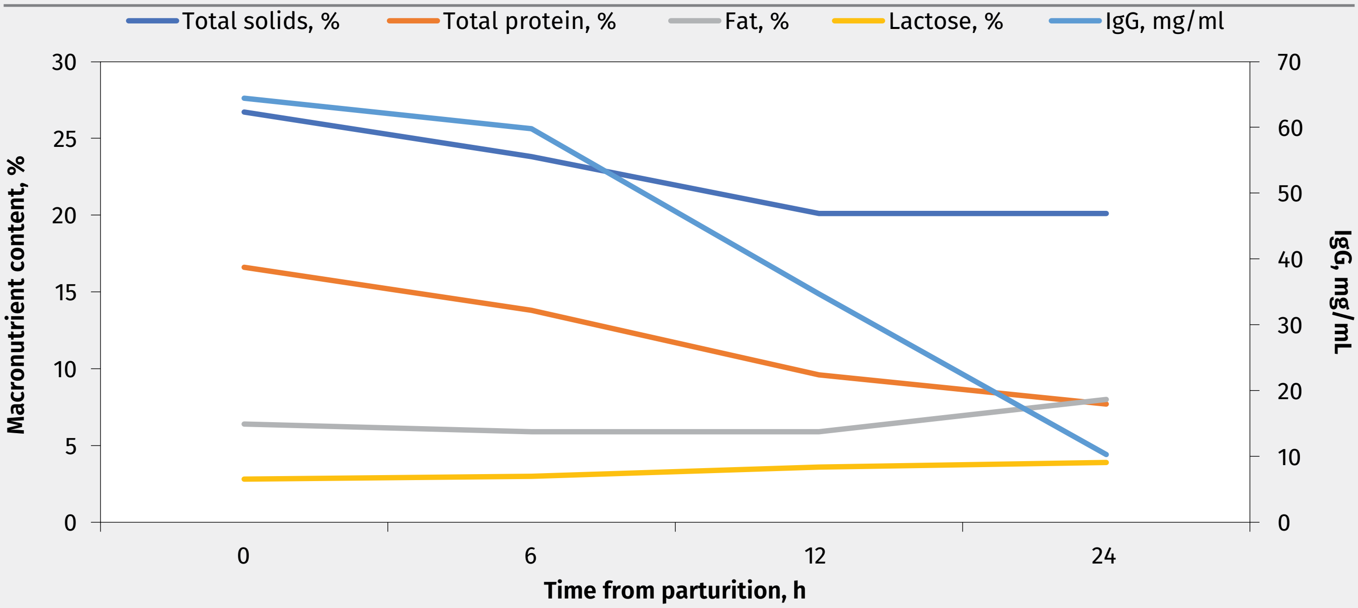
MRW, MDT, JCW, RDG, JMD: Department of Animal Sciences and Industry, Kansas State University, Manhattan, Kansas.

JTG: Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University, Manhattan, Kansas.

Corresponding author: Dr Jordan T. Gebhardt, Department of Diagnostic Medicine/Pathobiology, Kansas State University, Manhattan, Kansas; Email: **jgebhardt@vet.k-state.edu**.

Wensley MR, Tokach MD, Woodworth JC, Goodband RD, DeRouchey JM, Gebhardt JT. Feeding strategies to increase sow colostrum quality and yield. *J Swine Health Prod*. 2023;31(3):133-136. **https://doi.org/10.54846/jshap/1322**.

Figure 1: Average reported concentrations of macronutrient components and immunoglobulin G (IgG) of sow colostrum. Figure adapted from Hurley, 2015.[3]



decreased progesterone), it is believed that colostrum production begins during the last 7 to 10 days of gestation and continues through parturition[1,4,5] During this time period, mammary tight junctions are considered "leaky," which allows for the transfer of hormones, growth factors, and Ig into alveolar cells for storage until suckling stimuli occurs.[5] While the role of endocrine hormones in regulating colostrogenesis is not fully understood, the data available may suggest that nutritional strategies applied during the last 7 to 10 days of gestation could provide the greatest opportunity to increase colostrum yield. Likewise, little is known about the metabolic state of sows in colostrogenesis; thus, implementing feeding strategies to manage sow body reserves in late gestation may be an additional opportunity to improve colostrum yield. Supplying more nutrients through increased feed allowance is thought to decrease sow catabolism, therefore increasing the amount of nutrients available for colostrum synthesis and body condition (BC) maintenance.[6] This should prevent excessive body tissue mobilization which can negatively affect colostrum yield and composition. For example, females that were underfed (1.0 kg/d) the last 14 days prior to farrowing had a greater percentage of colostral fat and reduced colostral protein.[7] The authors speculated that this response was because underfed sows were synthesizing colostrum directly from body tissue. Increased colostral fat concentrations have also been observed in sows with innately low colostrum production. Although the authors did not address this response, low yielding sows exhibited a leakier mammary epithelium and reduced colostral lactose concentrations. These responses were related to delayed reductions in prolactin prepartum,[8] which may suggest that underfed sows have an abnormal endocrine response due to inadequate nutrient intake. More research in this area is needed to understand the potential mode of action between nutrient status and endocrine control.

Overfeeding sows during gestation has negative implications on colostrum yield. This is largely associated with BC because fat sows (backfat > 23 mm) often exhibit decreased colostrum yield, which is thought to be associated with increased fat accumulation in mammary tissue.[6,9] Because a high BC is generally a consequence of over feeding for an extended period, it is important to make sure females enter farrowing with an appropriate BC to maximize colostrum yield. In contrast, prefarrowing feed allowance appears to have a low impact on colostrum yield. Data by Gourley et al[10] showed no difference in colostrum yield if females were fed increased lysine and energy from day 107 or 113 of gestation to farrowing. Colostrum yield was also similar for females that were fed 2.7 kg/d or *ad libitum* starting at day 113 of gestation.[11] However, Decaluwé et al[6] observed a tendency for increased colostrum yield when sows were fed 4.5 kg/d compared to 1.5 kg/d starting at day 108 of gestation, with the greatest yield observed for sows that entered the farrowing house with a moderate BC (backfat = 19 mm). The feed allowance of 1.5 kg/d for control sows was below the sow maintenance requirements which could explain the response observed. While it appears that prefarrowing feed allowance has limited effects on colostrum yield, these data highlight the importance of making sure sows are fed at or slightly above requirement during colostrogenesis to prevent the use of body fat and protein reserves for colostrum production. These data are supported by earlier reports that showed increased serum non-esterified fatty acids and decreased backfat the week prior to farrowing were negatively associated with colostrum yield.[12]

Nutritional impacts on colostrum quality

Colostrum quality can be defined by the concentration of macronutrients, including carbohydrates (lactose), fat, and protein (specifically IgG) within a colostrum sample. Several experiments have been conducted to better understand the effects of sow nutrition on colostrum composition, however, the data lacks consistency. Of the macronutrients, colostral fat is the most easily changed through nutritional strategies.[13] Increasing the energy density of gestation diets through the addition of fat, such as choice white grease, tallow, soybean oil, or corn oil, provides the greatest opportunity to increase total colostrum fat.[14-17] Oil inclusion has also been shown to alter the fatty acid profile of colostrum,[18,19] regardless of prefarrowing timing (day 107 vs 112).[20]

Supplementing diets with high levels of leucine (Leu), valine (Val), and isoleucine (Ile) while maintaining the Leu:Ile:Val ratio may be another option to change the fatty acid profile of colostrum.[21] Valine by itself has also been shown to increase colostrum fat and protein concentrations when fed above NRC requirements.[22,23] Furthermore, some studies suggest that prefarrowing feed allowance influences protein and Ig concentrations, but the results are variable. Decaluwé et al[6] observed that increasing feed allowance from 1.5 to 4.5 kg/d starting on day 108 of gestation resulted in decreased colostrum protein percent, but not total protein. This also did not translate to differences in Ig content, which suggests that increased feed allowance did not change the nutrient composition of colostrum, but rather had a dilution effect. In contrast, Gourley et al[10] observed that increasing feed allowance from 2.7 to 3.8 kg/d starting on day 113 of gestation resulted in increased colostrum IgG concentrations (107 vs 125 mg/mL for gilts; 114 vs 131 mg/mL for sows) but not total protein percent (14.8% vs 14.9% for gilts; 15.3% vs 14.9% for sows). Other data suggests that supplementing the diet with conjugated linoleic acid, beta-carotene, or high levels of vitamin D can increase Ig.[24-27] Additional data has been generated for other nutritional strategies, but results are generally variable and additional research is needed to understand further. Protein levels in colostrum appear to be negatively correlated with lactose level,[28] which suggest a greater emphasis should be put on total colostral protein rather than lactose because of the Ig fraction of protein and its role in passive immunity.

Management impacts on colostrum quality and yield

Parity structure, farrowing induction, and gestation length contribute to variations in colostrum yield.[28] Nutritional influences on colostrum are challenging to replicate for this reason, which suggests management strategies may provide a better influence on colostrum yield and quality. The sow farm parity structure will influence colostrum output, consequently impacting litter performance. More specifically, multiparous females tend to have greater colostral IgG concentration than primiparous females, whereas primiparous females tend to have higher colostral fat concentrations.[10,29-32] Likewise, colostrum yield is generally greater in parity 2 and 3 sows compared to parity 4 and higher.[12] In addition to parity, sows that are induced prior to their expected farrowing date often exhibit decreased colostral fat and Ig concentrations. If early induction protocols are in place, feeding increased dietary energy prefarrowing can help mitigate these negative effects.[14] More recent data also suggests that administering oxytocin early post farrowing (75 IU oxytocin given twice daily beginning 12 to 20 hours after farrowing the last piglet for a total of 4 injections) will delay the tightening of mammary tight junctions, therefore increasing the output of colostrum protein and Ig.[33] However, follow up research is needed to identify if these results are able to be replicated. Gestation length is another factor that should be taken into consideration when assessing colostrum outputs, although it is often confounded with induction protocols. Increasing the gestation length beyond a sows expected farrow date will likely result in decreased colostral IgG concentrations.[14,30]

Acknowledgments

This work was supported by contribution No. 23-078-J from the Kansas Agricultural Experimental Station in Manhattan, Kansas.

Conflict of interest

None reported.

Disclaimer

Drs Gebhardt and Tokach, both members of this journal's editorial board, were not involved in the editorial review of or decision to publish this article.

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