

Choline is a Required Nutrient for Transition Dairy Cows

Multi-Study Research Summary

Meta-analysis of the effects of supplemental rumen-protected choline during the transition period on performance and health of dairy cows

Arshad, U., M. G. Zenobi, C. R. Staples, and J. E. P. Santos. 2020. *J. Dairy Sci.* 103:282–300.

Trial 1: Effects of supplementation with ruminally protected choline on performance of multiparous Holstein cows did not depend upon prepartum caloric intake

Zenobi, M.G., R. Gardinal, J. Zuniga, A. Dias, C. Nelson, J. Driver, B. Barton, J.E. Santos, and C. Staples. 2018a. *J. Dairy Sci.* 101:1088-1110.

Trial 2: Timing of initiation and duration of feeding rumen-protected choline affects performance of lactating Holstein cows

Bollatti, J. M., M. G. Zenobi, N. A. Artusso, G. F. Alfaro, A. M. Lopez, B. A. Barton, C. R. Staples, and J. E. P. Santos. 2020a. *J. Dairy Sci.* 103:4174–4191.

Trial 3: Increasing the prepartum dose of rumen-protected choline: Effects on milk production and metabolism in high producing Holstein dairy cows

Holdorf, H. T., S. J. Kendall, K. E. Ruh, M. J. Caputo, G. J. Combs, S. J. Henisz, W. E. Brown, T. Bresolin, R. E. P. Ferreira, J. R. R. Dorea, and H. M. White. 2023. *J. Dairy Sci.* 106:5988-6004.

Trial 4: Effects of dietary rumen-protected choline supplementation to periparturient dairy cattle on inflammation, metabolism, and performance during an intramammary lipopolysaccharide challenge

Swartz, T. H., B. J. Bradford, L. K. Mamedova, and K. A. Estes. 2023. *J. Dairy Sci.* In Press.

Trial 5: Production responses to rumen-protected choline and methionine supplemented during the peripartum period differ for primi- and multiparous cows

Potts, S. B., C. M. Scholte, K. M. Moyes, and R. A. Erdman. 2020. *J. Dairy Sci.* 103:6070-6078.

Balchem manufactures two versions of their rumen-protected choline product. ReaShure and a more concentrated form called ReaShure-XC. Both are designed to provide approximately 13 g/d choline ion when fed at the recommended feeding levels (ReaShure = 60/g/h/d, ReaShure-XC = 30 g/h/d). One or both of these products were used in the following trials.

Choline is a Required Nutrient for Essentially Every Cow

First discovered in 1862, choline was identified as a critical building block of molecules involved in many essential functions in humans and animals. Some of these critical functions include nerve transmission, cell wall structure and cellular signaling, methyl-group metabolism, lipid transportation and more recently immune function. Choline is recognized by scientists as a required nutrient for most mammals.

Unfortunately, choline is extensively degraded in the rumen of ruminant species and must be supplemented in a rumen-protected form. ReaShure® Precision Release Choline (Balchem Corp., Montvale, NJ) was introduced over 25 years ago and was originally used to address the high incidence of fatty liver (40-60%) in transition dairy cows, which severely impairs cow performance. Over the following 25 years, research involving over 25 University research studies has demonstrated that choline is essentially required to help all cows express their genetic potential. Essentially all cows, regardless of milk production, body condition, health status and age respond positively to choline supplementation during transition.

Methodologies

Meta-Analysis. Arshad et al. (2020) published the results of a meta-analysis of research studies looking at the effects of supplementing rumen protected choline (RPC) during transition on multiparous cow performance. There were 21 total studies in the analysis with 66 different treatments and over 1.300 cows. All studies used in the analysis fed RPC prepartum and for some period of time postpartum.

Trial 1. Zenobi et al. (2018a) was one of the trials included in the 21 studies in the Arshad meta-analysis. The study was a 2x2 factorial design using 109 parous cows fed either 0 or 60 g/d (12,9 g/d choline ion) ReaShure fed prepartum (21 d pre- to 21 d postpartum). Selection criteria included apparently healthy cows with no history of chronic disease before enrollment. The study also looked at the effect of dry cow diet energy (1,63 vs. 1,40 Mcal NE/kg DM) on performance and any interaction with ReaShure supplementation.

Trial 2. Bollatti et al. (2020b) also looked at the effect of prepartum supplementation of ReaShure at 60 g/d (12,9 g/d choline ion) on energy corrected milk (ECM) yield over 15 weeks and on milk yield over 25 weeks postpartum. There were 113 parous apparently healthy pregnant cows with no recent history of disease in the 90 days preceding enrollment.

Trial 3. Holdorf et al. (2023) more recently looked at the effects of prepartum ReaShure supplementation and prepartum (21 d) dose effects on lactation performance in 116 parous cows. Treatments were: 1) Control (0 g/d choline ion), 2) 15 g/d choline ion from ReaShure (pre- and postpartum), 3) 15 g/d choline ion from ReaShure-XC (pre- and postpartum) and 4) 22 g/d of choline ion from ReaShure-XC prepartum followed by 15 g/d of choline ion postpartum (21 d). Energy corrected (ECM) milk yield was measured and reported during the postpartum supplementation period (d 0 to d 21 postpartum) and for the subsequent post-supplementation period out to 100 DIM.

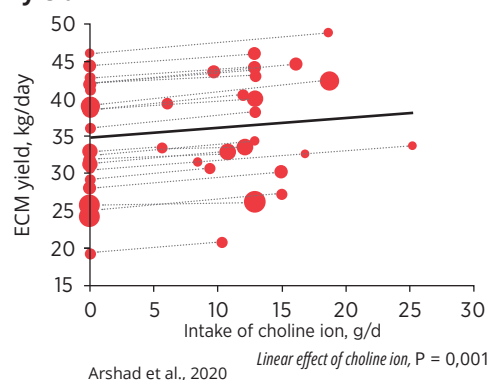
Trial 4. Swartz et al. (2023) evaluated the effects of choline ion dose on lactation performance in 67 parous cows. Treatments were: 1) control (0 g/d choline ion), 2) ReaShure-XC – recommended feeding rate, 30 g/d (13,6 g/d choline ion) or 3) ReaShure-XC – 150% of recommended feeding rate, 45 g/d (20,4 g/d choline ion) fed prepartum (21 d pre to 21 d postpartum). At d 17 postpartum, half of the cows on each treatment were challenged with an intramammary LPS challenge. All cows received a common diet starting on day 22 and performance was measured through d 84 of lactation.

Trial 5. Potts et al. (2020) conducted an experiment looking at the effects of ReaShure 60 g/d (12,9 g/d choline ion) fed 21 d prepartum through 35 d postpartum on early lactation performance of primiparous and multiparous cows. There were 25 primiparous cows and 29 multiparous cows. Treatments were: 1) Control (0 g/d RPC), 2) 60 g/d (12,9 g/d choline ion) of ReaShure, 3) 12 g/d rumen protected methionine or 4) 60 g/d (12,9 g/d choline ion) of ReaShure + 12 g/d RP of methionine.

Results

The response in ECM yield to supplementation of RPC during transition as reported by Arshad et al. (2020) is shown in Figure 1. The horizontal axis shows the level of choline ion fed. The vertical axis shows the ECM yield of the control cows (no choline) for each trial. The average increase in ECM (solid line) across all studies was 2,2 kg per day compared to control cows and ECM yield increased linearly with increasing level of RPC fed. Examination of the individual trial responses shows remarkably consistent positive ECM yield responses to RPC *regardless of starting milk production levels*. It also shows consistency in response across a wide range of management and nutrition practices.

Figure 1 Effect of supplemental choline on energy-corrected milk yield



Many of the earlier studies cited in the Arshad et al. (2020) meta-analysis only followed lactation responses for a few weeks postpartum. Zenobi et al. (2018a) was the first to follow performance into late lactation (40 weeks). ReaShure-supplemented cows (60 g/d 21 d pre- to 21 d postpartum (12,9 g/d choline ion)) produced 2,1 kg of ECM per day more than control cows over the entire 40 weeks of lactation (Figure 2). Dry cows fed a high-fiber maintenance diet or a higher energy diet both responded well to ReaShure supplementation. Bollatti et al. (2020b) showed a very similar response to ReaShure as seen in Zenobi et al. (2018a). In the first 21 d postpartum, ReaShure supplemented cows produced 3,1 kg more ECM per day than control cows. ECM continued to be higher (2,4 kg) for the following 12 weeks once ReaShure supplementation had ended (Figure 3). Milk yield was monitored out to 25 weeks with ReaShure-fed cows averaging 42,9 kg compared to 40,9 kg for control cows.

More recently, researchers at the University of Wisconsin (Holdorf et al., 2023) reported that ECM yield was not improved during the first 21 d postpartum when 15 g of rumen protected choline was fed from 21 d pre- to 21 d postpartum. However, from 22 to 100 d postpartum, ReaShure-XC-supplemented cows produced on average 2,4 kg more ECM per day (Figure 4). It is important to note that the control cows in this study were producing over 55 kg of ECM during this period.

Work by Swartz et al. (2023) at Michigan State University further supports the essentiality of choline during the periparturient period. Cows fed ReaShure-XC peripartum produced on average 3,8 kg more milk than control cows from calving to d 16 of lactation. During intramammary LPS challenge, cows saw significant decreases in milk yield that was not affected by treatment. In the subsequent period (d 22 to d 84), cows receiving ReaShure-XC produced 3,5 kg more milk per day than control cows. LPS challenged cows produced less milk regardless of treatment compared to unchallenged cows in the carry-over period. However, challenged cows that received ReaShure-XC maintained the higher level of milk production compared to challenged control cows.

It has been theorized that RPC might be best utilized in herds with over-conditioned dry cows. Bollatti et al. (2020a) did a retrospective analysis of the work done by Zenobi et al. (2018a) and Bollatti et al. (2020b) to see if prepartum BCS affected milk and ECM response to RPC supplementation. The prepartum mean BCS of both control and ReaShure-supplemented cows was 3,51 and the distribution of BCS was very similar as well. There were 215 cows in the analysis. The data showed that all cows, regardless of BCS, responded to ReaShure supplementation with increased milk and ECM yields (Figure 6).

Figure 2 Effect of feeding ReaShure during the transition period on milk production over the full lactation

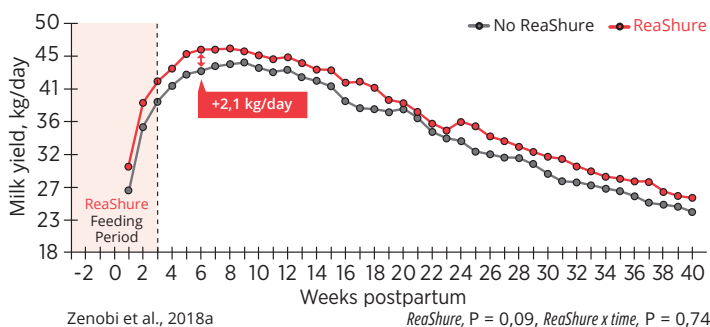


Figure 3 Effect of feeding ReaShure during the transition period on energy-corrected milk over the first 15 weeks of lactation

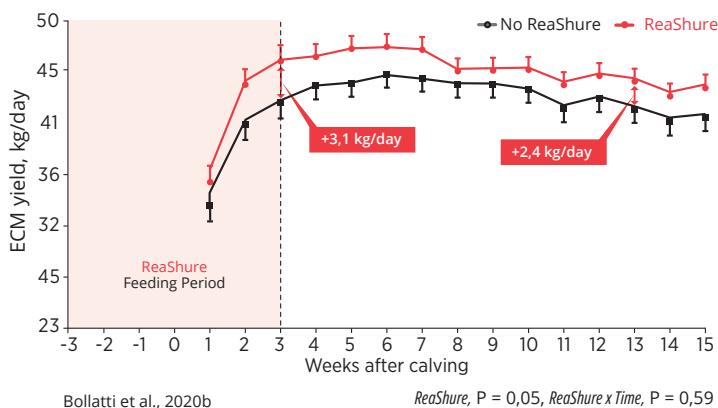


Figure 4 Effect of feeding ReaShure-XC during transition on energy-corrected milk yield through 14 weeks of lactation

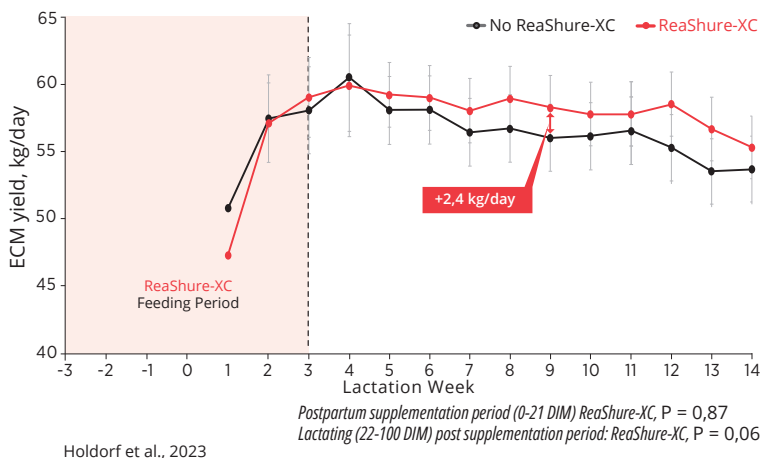


Figure 5 Effect of feeding ReaShure-XC during the transition period on milk yield through 12 weeks of lactation

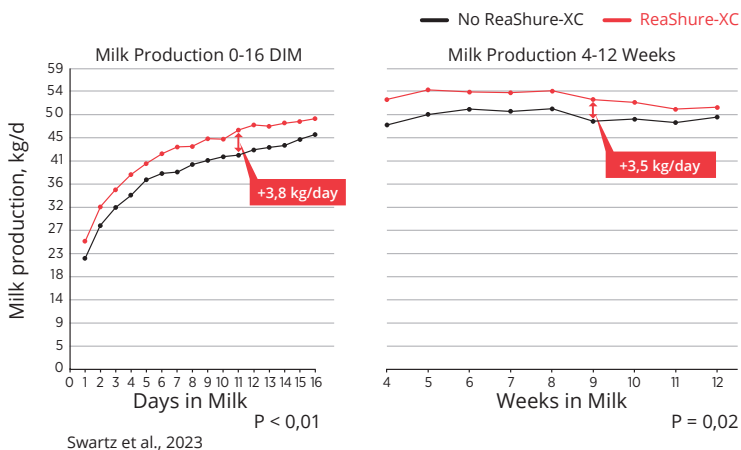
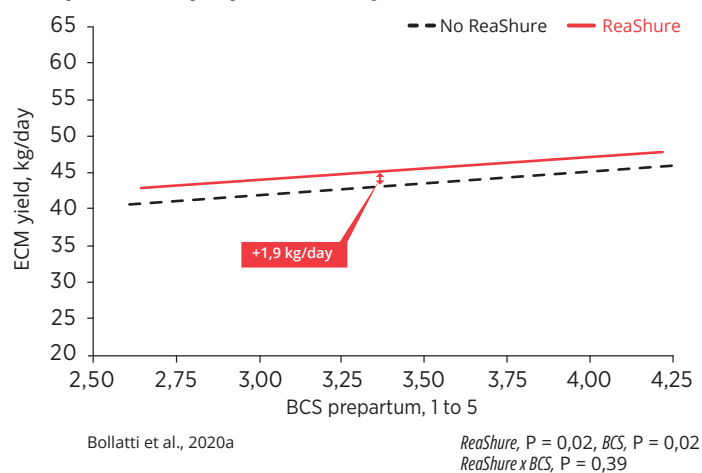


Figure 6 Energy-corrected milk yield response to ReaShure irrespective of prepartum body condition score



There is limited data available on how primiparous cows respond to ReaShure. Lima et al. (2012) reported an increased milk yield of 0,8 kg over the first 80 days of lactation in primiparous cows. There were 287 control cows (0 g/d RPC) and 291 ReaShure (60 g/d) supplemented cows. However, ReaShure was only supplemented prepartum for 22 days. In the study by Potts et al., (2020) primiparous cows fed ReaShure peripartum showed a 3,4 kg increase in milk yield per day compared to control cows.

Discussion

The Arshad et al. (2020) meta-analysis provided some important insights into the application of peripartum RPC supplementation. The consistency in response to RPC strongly supports that choline is an essential and required nutrient and that supplementation is required in transition cows to optimize performance. The data also supports that level of milk production in a herd should not be a determinant of use. In the meta-analysis, positive responses were seen at production levels from as low as 19 kg/d to over 47 kg/d. This is further supported by similar positive ECM production responses in Swartz et al. (2023) and Holdorf et al. (2023) in cows producing in excess of 50 kg/d and 56 kg/d, respectively.

These studies also cast doubt on the concept that choline is only needed in herds with substantial health challenges (metabolic disease incidences). High producing cows are healthy cows, yet the research shows that they still respond to ReaShure supplementation. The Bollatti et al. (2020b) analysis should dispel the idea that ReaShure is only needed when herds have over-conditioned cows predisposed to metabolic disorders. While more research is needed with primiparous cows, it does appear that they also respond to ReaShure supplementation.

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Summary

Essentially every cow has a need for ReaShure during transition to achieve optimal performance. While the exact mode for enhanced production is still debated, the need does not depend on production level, BCS, age, or health status. Scientists recognize that choline is required by virtually all transition cows. And the short-term investment during the transition period can result in long-term returns through higher peaks and greater milk yields over the entire lactation.*

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