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Effects of rumen protected choline chloride in dairy cows

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Introduction

Choline plays an important role in transportation of non-esterified fatty acids regarding metabolism by the liver and a shortage results in a disturbed fatty acid metabolism with the consequence of ketosis and fatty liver syndrome in dairy cattle. Unfortunately unprotected choline will degrade in the rumen therefore choline must be added to the diet in a rumen protected form. Trial results show that the use of protected choline is a preventive measurement for avoidance of fatty liver syndrome and ketosis around calving (Lima *et al.* 2007; Zom *et al.* 2011) and may improve milk production and reproduction parameters (Piepenbrink and Overton, 2003; Cooke *et al.* 2007). Aim of the trial was to examine the effect of rumen protected choline chloride on milk production and the incidence for ketosis in dairy cows under practical conditions.

Material and Methods

Hence, two practical trials were carried out in 2012 in the Netherlands, first a more comprehensive trial, followed by a practical approach at a second farm. In trial 1 (farm with in total 250 cows, lactating cows kept in 4 different groups, 1 automatic milking system per group) 90 multiparous fresh cows (from fresh cow group up to 100 days in milk) were followed up from calving to 90 days in milk, 45 as control and 45 as choline treatment. After calving fresh cows were randomly assigned to the control (no supplementation) or choline treatment. Choline (60 g/cow/day of a product containing 25% choline chloride) was supplied via a mineral feed dispenser at the milking robot to only treatment animals. Advantage of this system was keeping all cows in the same group by reducing external factors to a minimum. Milk performance was recorded on daily basis and milk composition once a month. Body condition scores of all cows were measured on day 7-10 after calving and at trial end by a veterinarian. No differences on BCS (average value 2.9, resp.) were obtained between treatments at trial start (Scale 1-5; 1 = thin, no fat reserves; 5 = fat, high fat reserves). Ketone bodies in urine of all cows were measured on day 7-10 after calving by the same veterinarian by the use of test stripes and scaled from 1-6 (1 = no ketones, 6 = extreme levels of ketones).
Trial 2 was carried out at a farm with in total 90 cows. Focus was on the fresh cows (fresh cow group up to 120 days in milk) by comparing the effect of a 4 weeks choline supplementation with historical data from that farm. The same choline product was used with a dosage of 50 g/cow/day (direct inclusion to the mixing wagon).
For statistical evaluation (only trial 1) lactation curves were modelled as a function of day in milk and thus a "random regression model" was used with (1) fixed regression coefficients (course of milk per group and test day) and (2) random regression coefficients (course of milk per animal with unstructured covariance matrix and residual effect) for the similar parameter. As regression approach the Ali & Schaeffer model was used. Additionally, a fixed test day effect was in included (details of the evaluation method, see Mielenz *et al.* 2006).

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Results and Discussion

In trial 1 the supplementation of rumen protected choline didn't significantly influence milk yield within the first 90 days in lactation (table 1), but differences between treatments increased numerically over the entire trial period and the choline group peaked higher and kept the highest production over a longer period (graph 1). Milk protein concentrations were similar between both treatments but supplementation of choline resulted in a significantly reduced milk fat concentration within the first 30 days in lactation and therefore also milk fat/protein ratio (signal for lower risk for subclinical ketosis) differed significantly in this period (table 1 and graph 2). The same tendency was measured for fat/protein quotient (not shown). It was also measured that the number of cows with an elevated fat/protein ratio above 1.25 (indication of ketosis) declined by the supplementation of choline. The percentage of cows was reduced from 50.0% in control to 35.3% in choline group (day 1-30) and from 35.3% to 19.4% (day 31-60), respectively.
Cows supplemented with choline showed a numerically reduced ketone body concentration in urine (2.22±1.40 vs. 2.62±1.66 in control; P=0.34) from which the conclusion can be drawn that together with the lower fat and fat/protein ratio this can be seen as a sign for reduced incidence for ketosis. Body condition score was not influenced on average (2.71±0.17 in choline; 2.61±0.16 in control; P=0.39) but a significant influence of time (lactation day) was detected as well as a tendency of treatment and time in favour to the choline supplementation for a higher BCS (P=0.13).

Table 1: Impact of rumen protected choline on average daily milk yield, milk composition, and milk fat/protein ratio (trial 1)

	Control Mean (SE)	**Choline** Mean (SE)	**Cholin – Control** Mean (SE)	**P =**
Milk yield				
day 1-30 (kg/d)	37.34 (1.04)	37.43 (1.02)	0.09 (1.29)	0.95
day 31-60 (kg/d)	42.20 (1.11)	42.57 (1.10)	0.37 (1.53)	0.81
day 61-90 (kg/d)	39.03 (1.20)	39.59 (1.22)	0.56 (1.57)	0.72
Milk fat				
day 1-30 (%)	**4.96** (0.12)	**4.58** (0.11)	**-0.38** (0.16)	**0.02**
day 31-60 (%)	4.01 (0.10)	3.92 (0.10)	-0.09 (0.14)	0.53
day 61-90 (%)	3.88 (0.10)	3.84 (0.09)	-0.04 (0.13)	0.78
Milk protein				
day 1-30 (%)	3.47 (0.07)	3.45 (0.06)	-0.02 (0.09)	0.83
day 31-60 (%)	3.05 (0.04)	3.07 (0.03)	0.02 (0.05)	0.76
day 61-90 (%)	3.13 (0.04)	3.12 (0.04)	-0.01 (0.06)	0.79
Milk fat/protein ratio				
day 1-30 (%fat-%protein)	**1.37** (0.12)	**1.07** (0.11)	-0.30 (0.16)	**0.06**
day 31-60 (%fat-%protein)	0.97 (0.09)	0.86 (0.09)	-0.12 (0.13)	0.37
day 61-90 (%fat-%protein)	0.78 (0.09)	0.75 (0.08)	-0.03 (0.12)	0.37

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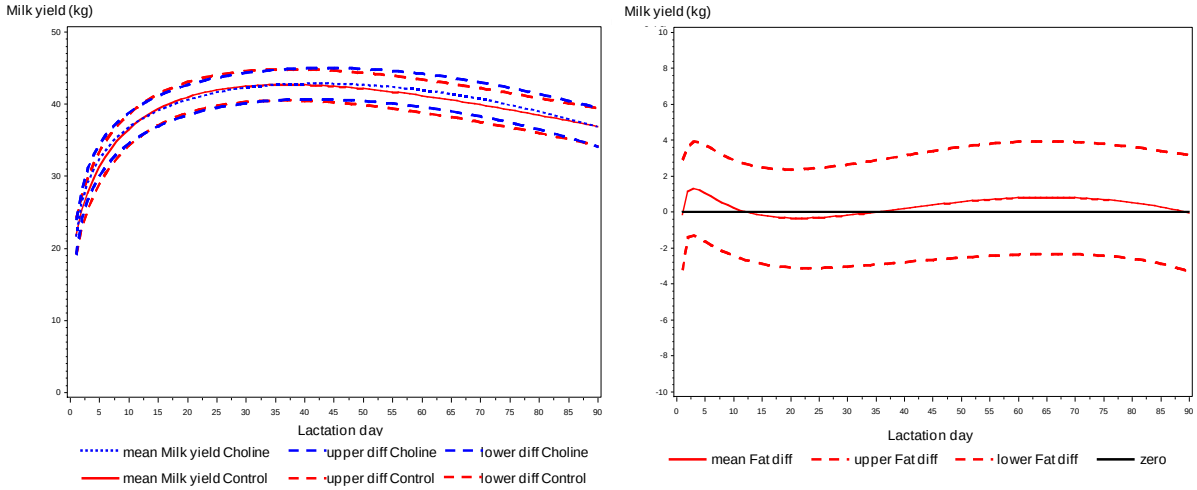
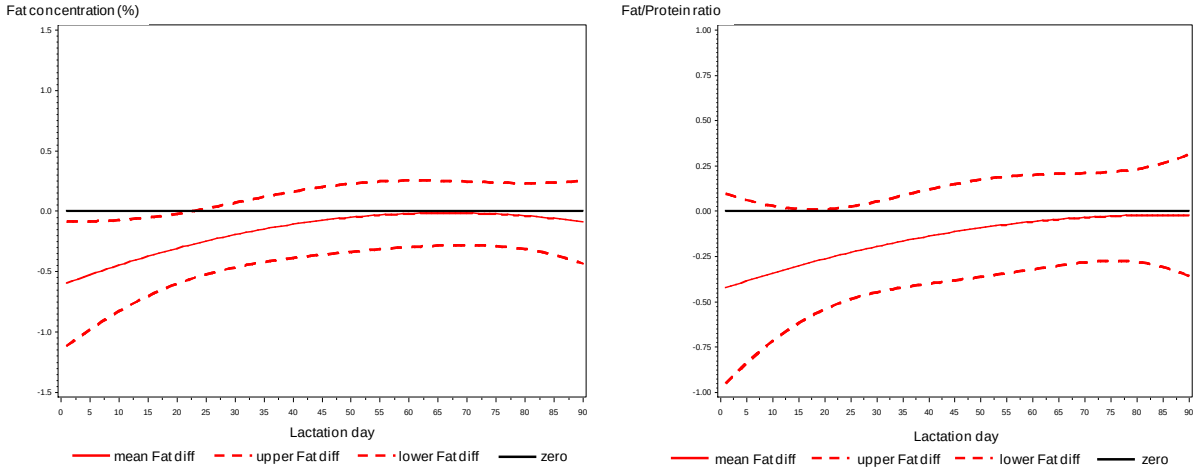


Graph 1: Lactation curves and differences in daily milk yield (choline – control) in dependence of choline supplementation (LSMEANS and similar two-sided confidence intervals, P = 0.95)



Graph 2: Differences in milk fat concentration and milk fat/protein ratio (choline – control) depending on choline supplementation (LSMEANS and similar two-sided confidence intervals, P = 0.95)

In trial 2 (table 2) feeding rumen protected choline resulted after 4 weeks in a reduced amount of cows "at risk" (too high milk fat/protein ratio) which was almost reduced by half. Also fewer animals were observed with a high ketone body concentration in milk. These results, although only compared with the historical data, confirm very well the results of the first experiment.

Table 2: Percentage of cows with elevated fat/protein ratio, and high ketone bodies in milk before and after 4 weeks of choline treatment (trial 2)

	Before	**After 4 wks**
% cows of milk fat/protein ratio > 1,25 (F-P > 1.25)	61%	32%
No. of cows with elevated ketone bodies in milk	4	1

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Summary

Rumen protected choline is a preventive measurement against fatty liver syndrome and ketosis after calving. In two trials rumen protected choline was used to proof the effects described in literature under practical conditions. In trial 1, feeding rumen protected choline didn't influence milk yield but levels of ketone bodies in urine, fat concentration and fat/protein ratio in milk were reduced esp. within the first month of lactation which can be considered as a lower incidence for subclinical ketosis. The results of the 1st trial were confirmed in a practical approach where in contrast to historical results fewer cows showed symptoms of ketosis.

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