

Investigation between Different Amount of Crude Fiber and Fermentation in the Rumen by Beef Suckler Cows

Heiko Scholz¹, Petra Kühne¹, Rudolf Staufenbiel², Anja West² and Gerd Heckenberger³

1. *The Department of Agriculture, Oecotrophology and Rural Development, Anhalt University of Applied Sciences, Bernburg 06406, Germany*

2. *The Department of Veterinary Medicine, Freie Universität, Berlin 14163, Germany*

3. *The Department of Animal Husbandry and Breeding, State Institute of Agriculture and Horticulture, Iden 39606, Germany*

Abstract: Body condition of suckler cows at the time of calving has an important effect on calving ease and mortality of calves. In the last eight weeks before calving the body condition should be reduced or at least not increased. Rations with a higher amount of crude fibre can be used (rations with straw or late mowed grass silage (GS)) to control the body condition score. Eight suckler cows (Charolais) were feeding a total mixed ration (TMR) in the last eight weeks before calving and GS after calving. By the addition of straw (30% in TMR1 vs 60% in TMR2 of dry matter) was varied the amount of crude fibre in the TMR (GS, straw, mineral) before calving. In the period after calving were GS feeding. Last measurement took place on the pasture (PS). Rumen fluid, plasma, body weight and back fat thickness were collected. Rumen fluid pH was assessed immediately after collection using an electronic pH meter. Volatile fatty acids (VFA), sedimentation, methylene-blue and amount of infusorians were measured. From four key figures an “index of rumen fermentation” (IRF) in the rumen was formed. Statistical analysis took place with analysis of variance (ANOVA) with fixed effects of treatment (TMR1, TMR2, GS and PS) and number of lactations (3-7 lactations) using SPSS Version 25.0 for Windows. Rumen fluid pH had significant differences between variants (TMR1 by 6.6, TMR2 by 6.9, GS by 6.6 and PS by 6.9), but was not affected by other effects. The IRF showed a disturbed fermentation in the rumen by feeding the TMR 1 + 2 with high amount of crude fibre (score: > 10.0 points) and a very good situation for fermentation during grazing the PS (score: 6.9 points). The long-term use of crude fibre-rich rations in the period before calving may cause deviations from undisturbed fermentation in the rumen and adversely affect the utilization of the feed in the rumen.

Key words: Suckler cow, crude fibre, rumen fermentation, body condition score, calving period.

1. Introduction

An adapted body condition of suckler cows at the time of calving is decisive for the birth process of the animals and the performance of the cows postpartum [1]. On the other hand, however, sub-conformation is also negative from a health point of view as well as for reproduction or fertility [2, 3]. The body condition can be recorded visually via the body condition score (BCS) or the measurement of the back fat thickness (RFD). An average BCS score of 3.0-3.5 (grades 1-5) or 5-6 (US 1-9 scores) or mean spine fat thickness of 20-25 mm is recommended for calving [4]. The

recommended course of body condition is shown in Fig. 1.

In the period from weaning of the calves to the following calving, however, the use of crude fiber-rich and therefore protein-poor rations is often found to allow control of the physical condition of suckler cows [5, 6]. From surveys and analyses on suckler cow farms in Central Germany, crude fiber contents of 32% to more than 40% were observed in the dry period. Compared to feed straw with 42%-45% crude fiber, there are only minor differences here. The effects of a very high increase of the crude fiber and concomitant reduction of the crude protein content on the rumen fermentation in the phase of calving cannot yet be conclusively answered. Here the investigations in the LLG Iden

Corresponding author: Heiko Scholz, Ph.D., professor, research fields: animal nutrition and economics in agriculture.

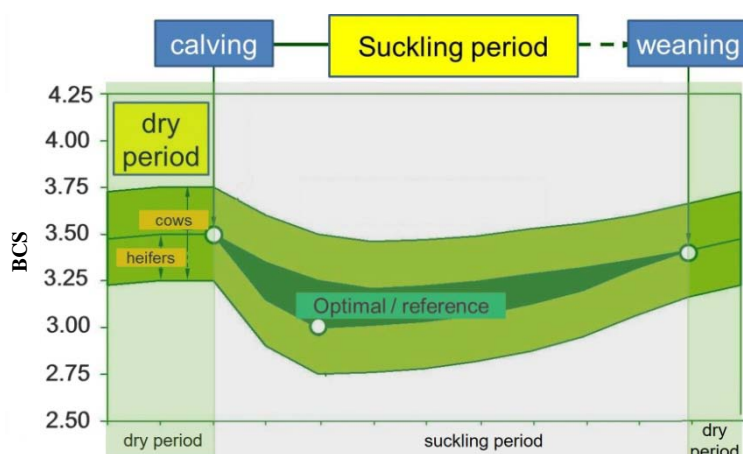


Fig. 1 Development of body condition score (BCS) of suckler cows [4].

started to examine the recommendations for feeding taking into account the effects on the rumen fermentation.

2. Materials and Methods

In the studies at the LLG Iden, different rations for dry suckler cows were examined. For this purpose, only the proportion of straw in the rations was varied in order to make practical statements possible. A total of three variants were used: total mixed ration (TMR) with 30% straw (TMR1), TMR with 60% straw (TMR2) and pure grass silage (GS) feeding after the calving of suckler cows and then starts the grazing season on pasture (PS). The composition of the rations is shown in Table 1, with always about 2% of the rations being supplemented with mineral feed.

Daily feed intake was measured by individual mangers that are placed on weighting cells (Fig. 2). Cows are identified by ear tags. If the cow is allowed access to a manger the gate goes down. When the allowed access time for that period is up,

the access gate goes up to push the cow away from the manger so that another cow can get to the gate. The weight of the manger is measured before the visit and after the animal access and the weight difference is transferred to a computer for analysis. Dry matter of the TMR was determined daily and then the daily dry matter intake of the suckler cows was calculated.

Rumen fluid, plasma, body weight and back fat thickness were collected. Rumen fluid pH was assessed immediately after collection using an electronic pH meter. Volatile fatty acids (VFA), sedimentation, methylene-blue and amount of infusorians were measured. From four parameters an “index of rumen fermentation” (IRF) in the rumen was formed (Table 2).

Statistical analysis took place with analysis of variance (ANOVA) with fixed effects of treatment (TMR1, TMR2, GS and PS) and number of lactations (3-7 lactations) using SPSS Version 25.0 for Windows. An alpha of 0.05 was used for all statistical tests.

Table 1 Composition of rations during calving period 2016/2017.

Ration	Grass silage	Alfalfa	Straw	Mineral
TMR1	53%	15%	30%	2%
TMR2	38%	-	60%	2%
Grass silage	98%	-	-	2%

TMR: total mixed ration.



Fig. 2 Individual mangers in LLG Iden (Saxony Anhalt, Germany).

Table 2 Index of rumen fermentation by West [7].

Parameter	Points	Sedimentation	Methylene-blue	Amount of infusorians	Movement of infusorians
Score 1	1	3-9 min	Up to 3 min	Plenty	Lively
Score 2	2	10-15 min	≥ 6 min	Moderate	Lazy
Score 3	3	≥ 15 min	Not measurable	Scant	Scant

3. Results

It was shown very clearly that the number of microbes and the activity of the rumen infusoria were significantly reduced with a longer use of crude fiber-rich ration compared to the findings from dairy cattle husbandry (Fig. 3). This large reduction in microbes and their activities is likely to result in the microbes in the rumen taking a very long time to adapt following the conversion of suckler cows from a high fiber ration to calving at the onset of the grazing period. This may, for example, have a lasting impact on the digestibility of the feed, because studies on the efficiency of nitrogen use in suckler cows show that such abrupt changes will result in very high levels of urinary nitrogen excretion.

Significant differences in the rumen pH of suckler cows can be observed between ration, GS and willow varieties, but overall the pH is at a very good level of 6.7 (Fig. 4). Against this background, the crude fiber-rich rations appear to be without rumen effects.

Furthermore, significant differences could be found for methylene-blue (significant decrease of duration/time period in the test) and the amount of infusorians (significant increase from TMR with straw

to GS and PS). VFA were significant influenced by variants. Table 3 shows the percentage of C2, C3 and C4 in rumen fluid by variants.

Furthermore, a “rumen index” according to West [7] was formed from the four key figures (movement and number of infusoria as well as methylene-blue sample and sedimentation), which should better describe the processes of fermentation in the rumen. For this purpose, all four parameters were divided into three groups and these groups were weighted with the same value. Then, for the individual cows, the points for the rumen index were summarized and reported as mean values of the rations. The calculated rumen index of suckler cows showed very large deviations between the different rations (Fig. 5). While the two crude fiber-rich rations with 30% straw and 60% straw achieved a mean score of more than 10 points and were thus classified as “disturbed rumen fermentation”, feeding rations of GS and PS significantly improved the score for the rumen index observed [7]. However, when evaluating the results, it should be noted that the rations rich in crude fiber were fed only in the period before calving and that GS and PS were used after the calving of suckler cows.

Investigation between Different Amount of Crude Fiber and Fermentation in the Rumen by Beef Suckler Cows

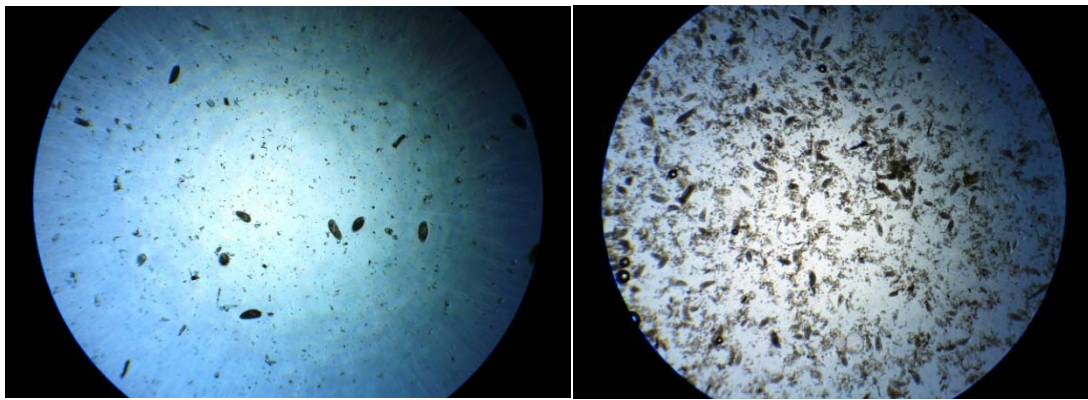


Fig. 3 View of the rumen liquid activity and amount of infusoria of beef suckler cows (left) and dairy cows (right).

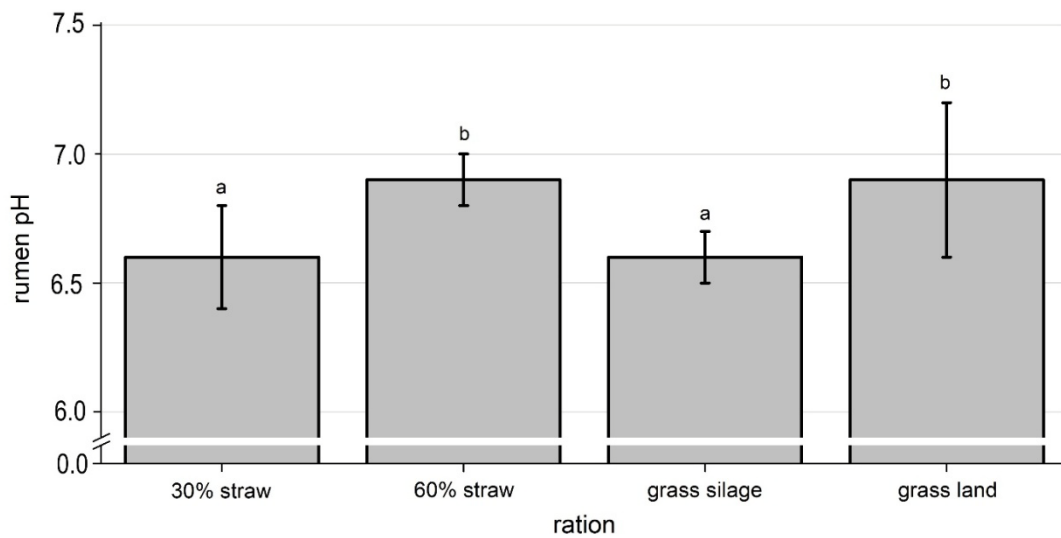


Fig. 4 Rumen pH of suckler cows in dependent of different rations during the transition period.

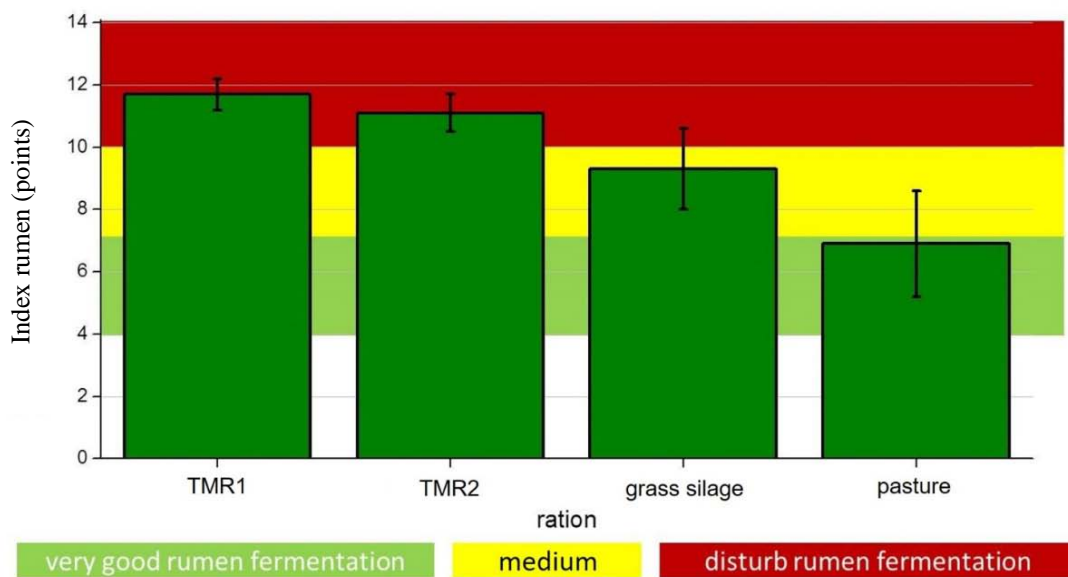


Fig. 5 Rumen index of suckler cow with different rations.

Table 3 Percentage of voluntary fatty acids in rumen fluid.

	30% straw	60% straw	Grass silage	Pasture
C2	69.6 ^a ± 2.7	70.9 ^{ac} ± 2.4	68.1 ^d ± 1.7	65.6 ^b ± 0.4
C3	18.7 ^a ± 1.5	18.5 ^c ± 0.9	20.1 ^{ad} ± 1.2	17.0 ^b ± 0.8
C4	8.9 ^a ± 0.8	8.6 ^a ± 1.3	9.5 ^a ± 0.5	12.1 ^b ± 0.5

ab, cd within a row are significant by $p \leq 0.05$.

Overall, it can be deduced from the results so far that even with the use of crude fiber-rich rations, the pH value in the rumen of the suckler cows is not adversely affected despite the majority of low fiber intake (in some cases less than 2,500 g/d, optimally 2,800 g/d) becomes. However, the sustainable effects on fermentation in the rumen should be taken into account in order to ensure efficient suckler cow husbandry with the best utilization of the feed quantities over the long term.

4. Discussion

The investigation shows the reduction of the number of microbes and the activity of rumen infusoria with a higher content of crude fibre in the rations of suckler cows. Allen [8] found comparable results in dairy cattle. Fibre requirement for dairy cattle should be determined by considering both the physically effectiveness and the production of fermentation acids [8]. For the present investigation, it can be concluded that more parameters must be analyzed for accurate prediction of the effects on rumen fermentation. This is also shown by the investigation from Sousa *et al.* [9] in finishing beef cattle. Overall can conclude that a limitation of dry matter intake results from a lower digestion and passage of fibre [10]. In the present study, a decrease in dry matter intake with higher amount of crude fibre and a lower amount of rumen infusoria were observed.

Dry matter intake can be limited by excess fermentable carbohydrates and low energy demand [10]. Investigation of Mertens [11] estimated a maximum rumen fill with neutral detergent fibre intake of 12.5 g per kilogram live weight and Huhtanen *et al.* [12] of 13.4 g neutral detergent fibre (NDF) per kilogram live weight of the cattle. Against

this background, programs in Germany for the extensification and “natural reserve” (like nature conservancy) of grassland do not appear to be effective, as this increase the content of crude fibre and neutral detergent fibre during the grazing season and the silages.

5. Conclusions

Feed intake of 100 MJ metabolized energy (ME) per day should be ingested in the phase of high-risk pregnancies, which with an average feed intake of 12 kg dry matter per day has an energy density of at least 8.0 MJ ME (or 4.8 MJ net energy lactation (NEL)) per kilogram of dry matter. Lower energy densities with then significantly increased levels of crude fiber (over 30%) reduce the dry matter intake sustainably and demonstrably reduce fermentation in the rumen. From their own studies on feed intake of suckler cows in the last four weeks before calving and the first four weeks after calving, the crude fiber content should not exceed 30%. This means that GS mid-flowering should be considered as the latest use for suckler cow husbandry. Against this background, programs such as KULAP or other programs with a late cut requirement for energy- and nutrient-adapted feeding do not appear to be effective in this extensive livestock farming process.

References

- [1] Singh, R., Randhawa, S. N. S., and Randhawa, C. S. 2015. “Body Condition Score and Its Correlation with Ultrasonic Back Fat Thickness in Transition of Crossbreed Cows.” *Vet World* 3 (8): 290-4.
- [2] Kadivar, A., Ahmadi, M. R., and Vatankhah, M. 2014. “Associations of Prepartum Body Condition Score with Occurrence of Clinical Endometritis and Resumption of Postpartum Ovarian Activity in Dairy Cattle.” *Trop. Anim. Health Prod.* 46: 121-6.

Investigation between Different Amount of Crude Fiber and Fermentation in the Rumen by Beef Suckler Cows

- [3] Roche, J. R., Macdonald, K. A., Schütz, K. E., Matthews, L. R., Verkerk, G. A., Meier, S., Loor, J. J., Rogers, A. R., McGrowan, J., Morgan, S. R., Taukiri, S., and Webster, J. R. 2013. "Calving Body Condition Score Affects Indicators of Health in Grazing Dairy Cows." *J. Dairy Sci.* 96 (9): 5811-25.
- [4] DLG. 2009. "Recommendation for Feeding Suckler Cows and Their Offsprings." DLG-Arbeitskreis Fütterung und Futter, DLG, Frankfurt am Main. (in German)
- [5] Kavanagh, S., Mcgee, M., and Fitzgerald, L. 2017. *Feeding the Suckler Cow*. TEAGASC, 205-11.
- [6] Murphy, M., Drennan, M. J., O'Mara, F. P., and Mcgee, M. 2008. "Performance and Feed Intake of Five Beef Suckler Cow Genotypes and Pre-weaning Growth of Their Progeny." *Irish Journal of Agricultural and Food Research* 47: 13-25.
- [7] West, A. 2017. "Rumen pH Values in Dairy Cows and Relationships with Key Figures for the Acid-Base Balance." Presented at the 10. Mitteldeutscher Rinder Workshop, Anhalt University of Applied Sciences, Bernburg, Germany, April 28-29, 2017. (in German)
- [8] Allen, M. 1997. "Relationship between Fermentation Acid Production in the Rumen and the Requirement for Physically Effective Fibre." *J. Dairy Sci.* 80: 1447-62.
- [9] Sousa, D., De Sousa Mesquita, B., Vaz Pires, A., De Almeida Santana, M. H., and Silva, L. F. P. 2017. "Effects of Fibre Digestibility and Level of Rough Age of Performance and Rumen Fermentation of Finishing Beef Cattle." *Trop. Anim. Health Prod.* 49: 1503-10.
- [10] Allen, M. 2014. "Drives and Limits to Feed Intake in Ruminants." *Animal Production Science* 54: 1513-24.
- [11] Mertens, D. R. 1994. "Regulation of Forage Intake." In *Forage Quality, Evaluation, and Utilization*, edited by Fahey, M. C. G. C., Mertens, Jr, D. R., and Moser, L. E. American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America, Madison, Wisconsin, USA, 450-93.
- [12] Huhtanen, P., Detmann, E., and Krizsan, S. 2016. "Prediction of Rumen Fiber Pool in Cattle from Dietary, Fecal, and Animal Variables." *J. Dairy Science* 99: 5345-57.