Dry matter intake, body condition score, beta-hydroxy-butyrate, milk yield, and composition of Holstein and crossbred Holstein x Simmental cows during the transition period

Deise Aline Knob\(^a\),\(^b\), Armin Manfred Scholz\(^b\), Roberto Kappes\(^a\), Wagner Bianchin Rodrigues\(^c\), Dileta Regina Moro Alessio\(^d\), Laiz Perazzoli\(^a\), Bruna Paula Bergamaschi Mendes\(^a\) and Andre Thaler Neto\(^a\)

\(^a\)Programa de Pós-graduação em Ciência Animal, Centro de Ciências Agroveterinárias, Universidade do Estado de Santa Catarina - CAV/UDESC, Lages, Brasil; \(^b\)Ludwig Maximilians Universität München (LMU), Tierärztliche Fakultät, Lehr- und Versuchsgut Oberschleißheim, Oberschleißheim, Deutschland; \(^c\)Instituto Federal Catarinense, Campus Santa Rosa do Sul. Santa Rosa do Sul, Santa Catarina, Brasil; \(^d\)Centro Universitário Leonardo da Vinci, Indaial, Brasil

ABSTRACT
We compared the dry matter intake (DMI), body condition score (BCS), body weight (BW), beta-hydroxy-butyrate (BHB), milk yield, and milk composition during the transition period of Holstein and crossbred Holstein x Simmental cows. Thirty cows were used in the study. Each cow entered the study 21 days before their expected calving day (prepartum) and remained in the study until day 21 after calving (postpartum). DMI, and milk yield were recorded daily. Once a week, BW and BCS were recorded and blood was collected to measure the BHB. The SAS software was used for the statistical analysis. Holstein and crossbred Holstein x Simmental cows had similar DMI during the prepartum and postpartum periods with higher intakes after calving. Crossbred Holstein x Simmental cows had a higher BCS than Holstein cows during the prepartum and postpartum periods. BHB does not differ between genetic groups, but between periods – with lower values in the prepartum period. The genetic groups had similar milk yield and composition. Both genetic groups lost BCS after calving, but Holstein cows showed a greater decrease in BCS. The use of a crossbreeding programme with Simmental has no negative effect on the performance during the transition period in Holstein herds.

Introduction
Crossbreeding between dairy breeds is an alternative to pure breeding that has been used to improve phenotype characteristics (related mainly to fitness) or to reduce the problems associated with the relatively high inbreeding rates in purebred herds (Weigel and Barlass 2003; Cassell and McAllister 2009). In addition to the reducing inbreeding, the genetic variability of the herds should improve and combine utilizing heterosis with complementarity effects (Mendonça et al. 2014). Positive heterosis effects can improve feed efficiency by reducing the energy required for maintenance, and deposition of body tissues due to the improved partitioning of consumed energy (Prendiville et al. 2009; Olson et al. 2010). Heins et al. (2008), for example, showed that crossbred Holstein x Jersey cows had higher dry matter intakes proportional to body weight (BW), better feed efficiency, allocated a bigger portion of energy to body reserves which enabled cows a quick recuperation of their body condition score (BCS) after calving. A favourable BCS of the crossbred Holstein x Jersey cows might have a positive impact on the reproductive performance for example, in comparison to Holstein cows (Heins et al. 2008).

The transition period of dairy cows is receiving more attention resulting in more studies investigating the physiological and metabolic changes at the end of the dry period and the beginning of a new lactation. One of the changes is the reduction in the dry matter intake (DMI) at the end of the dry period, which may amount to almost 30% 24 h before calving (Dewhurst et al. 2000). The DMI reduction can reach 3.8 kg of dry matter, leading to a reduction of the rumination time – of up to 60 min/day (Schirmann et al. 2013). After calving, a gradual increase of DMI is expected (Youssef and El-Ashker 2017), although the DMI does not increase as fast as the rise in demand for nutrients for milk production. The animals go through a deficient energy period, well recognized as a negative energy balance (NEB) (Mann et al. 2016; Barletta et al. 2017; Djoković et al. 2017). An NEB may lead to an increase in the concentration of non-esterified fatty acids (NEFA), which indicates body fat mobilization (Mendonça et al. 2014).

NEFA can be used as a direct energy source for the tissues or may be completely oxidized in the liver resulting in ketone bodies, especially beta-hydroxy-butyrate (BHB), which can be used as an energy source by the liver or other tissues (Barletta et al. 2017; Djoković et al. 2017). Situations when the NEFA and BHB levels are higher than the healthy limits for a cow (plasma or serum concentration >0.4 mmol/l or >1.2 mmol/l, respectively)
respectively), have been associated with lower milk yields, a reduced reproductive performance, higher risks of clinical and metabolic diseases, and finally an increased culling rate of the animals (Leblanc 2010; McCarthy et al. 2015).

The effects of NEB around the transition period have been frequently studied in high yielding herds, especially Holstein herds. Limited studies exist comparing Holstein and crossbred cows in this specific period. Crossbred cows may differ from Holsteins in DMI, the energy use efficiency, and energy metabolism due to heterosis and complementarity effects (Mendonça et al. 2014). Our study tests the hypothesis that crossbred Holstein x Simmental cows reduces DMI during the weeks before calving to a lower degree while showing a higher DMI immediately after calving with a similar milk yield to purebred Holsteins. Therefore, we aimed to compare DMI, BCS, BW, BHB, milk yield, and milk composition during the transition period (3 weeks before calving until 3 weeks after calving) for both breeding groups.

Material and methods

All procedures used in this research were approved by the Santa Catarina State University Ethical Committee, protocol n° 6330030517.

Animals and management

A commercial dairy farm located in Santa Catarina, South Brazil served as the experimental location for this study. The farm uses a compost bedded pack barn confinement system (CBP). The herd consists of approximately 280 lactating cows with 60% purebred Holstein cows and 40% crossbred Holstein x Simmental cows. A total number of 30 multiparous cows (18 Holstein and 12 crossbred F1 Holstein x Simmental cows) were used in the study. The crossbred cows originated from random crossings between purebred Holstein cows inseminated with semen from five Simmental bulls (DE 000935703404, DE 000812666322, DE 000812187178, DE 000939181646) which were imported from Germany and selected for their dairy breeding values (https://www.lfl.bayern.de/itz/rind/bazi/index.php?suche=#). The study was performed from August to November 2017. All cows with three or more parities that calved within the experimental time were included in the study. The cows underwent a prepartum period of 60 days before the expected calving day. Each cow entered the study 21 days before the expected calving day (prepartum) and stayed in the research group until day 21 after calving (postpartum). Therefore, the study covered a six-week transition period. Cows entered and left the pre- and postpartum groups according to their expected and actual calving dates. The prepartum group stayed with all other prepartum and postpartum groups according to their expected and actual calving dates. The prepartum group was the same as the diet offered to the other postpartum and high yielding cows in the farm. The diet was a total mixed ration (TMR) based on maize silage, ryegrass (fresh and silage), and concentrates. The ingredients and the chemical composition of the pre and postpartum diet are shown in Table 1. The diet offered to the cows was calculated to provide 100% of their nutritional requirements (NRC 2001). Both groups (prepartum and postpartum) had restricted access to food, food was only provided in the feed parlour. This routine corresponds to the dairy farm regime. During the rest of the day, the cows rested in the CPB (postpartum) or in the dry-cow paddock (prepartum).

Milkling took place three times a day (05:00 h, 13:30 h, and 20:30 h) and was combined with an electronic recording (DeLaval®) of the individual milk yield (MY). Individual milk samples were taken every 7 days in 40-ml bottles containing Bronopol. Each sample consisted of a pooled sample of the three milkings for the day. Samples were sent to the laboratory for milk analysis. The samples were analyzed for milk composition by an infrared method using the DairySpec equipment (Dairy Spec FT, Bentley®, USA).

After each milking, the postpartum cows had access to the feed parlour for approximately 2 h and 30 min – totalling approximately 7.5 h per day. The feed parlour had a self-locking feed front. The cows were already familiar with the system as part of the usual farm routine. The TMR offered was weighed and provided individually for measuring individual feed intake. The TMR was offered semi-ad libitum for each cow allowing a 5–10% residual and was prepared using a horizontal forage mixer. After the cows left the feed parlour, the non-consumed feed was weighed. Once a week, samples of the TMR offered and the residual from each cow (as well as the individual ingredients of the diet), were collected, and then dried in a forced-air oven at 55 °C for 72 h. After this procedure, the samples were milled through a 1-mm screen for chemical analyses. The dry matter content was determined by drying the samples at 105 °C for 24 h. The ash was quantified by combustion in a muffle furnace at 550 °C for 4 h, and the organic material was quantified by the mass

| Table 1. Ingredients and composition of TMR (% of dry matter) offered to the dry (prepartum) and lactating (postpartum) Holstein and crossbred Holstein x Simmental dairy cows. |
|----------------------------------|-----------------|-----------------|
| Ingredients                      | Prepartum diet  | Postpartum diet |
|----------------------------------|-----------------|-----------------|
| Corn silage                      | 72.6            | 16.2            |
| Ryegrass fresh                   | –               | 38.9            |
| Ryegrass silage                  | –               | 6.5             |
| Commercial concentrate           | 27.4            | 15.7            |
| Brewery waste                    | 15.7            | 1.9             |
| Soybean hull                     | –               | 4.5             |
| Ground corn                      | –               | 0.6             |
| Mineral mix (commercial)         | –               | –               |
| Chemical composition             |                 |                 |
| Dry Matter %                     | 31.73           | 34.13           |
| Organic material                 | 93.3            | 91.81           |
| Ash                             | 6.7             | 8.19            |
| Crude Protein                    | 12.68           | 15.44           |
| Ether Extract                    | 3.62            | 5.04            |
| NDF (neutral detergent fibre)    | 43.5            | 43.37           |
| ADF (Acid detergent fibre)       | 20.92           | 20.74           |
| NFC (non fibre carbohydrates)    | 33.91           | 28.5            |

*Values were obtained from the chemical analysis of TMR samples. NFC = 100 – (% CP + % NDF + % fat + % ash)
difference. The total nitrogen was assayed using the Kjeldahl method (method 984.13; AOAC International, 1998). The neutral detergent fibre (NDF) concentration was assessed according to Mertens (2002), except that the samples were weighed in filter bags and treated with a neutral detergent using Ankom A220 equipment (Ankom Technology, Macedon, NY). The concentration of the acid detergent fibre (ADF) was analyzed according to AOAC International (1998). The procedures described for DMI measurements, TMR sampling, and chemical TMR analyses were the same regardless of stage in the transition period.

Once a week, BW and BCS were recorded. We performed the BCS evaluation using a scale between 1 (extremely thin) and 5 (very fat), with 0.25 intervals (Ferguson et al. 1994). On the same day, all cows were weighed (after milking for the lactating cows), just before feeding. On the same day, blood was collected by the Heatime® (SCR/Allflex) system composed of a neck collar with a tag that records the rumination time (in minutes) of each cow.

To obtain the daily rumination data, we used the data collected by the Heatime® (SCR/Allflex) system, an automatic system composed of a neck collar with a tag that records the rumination time (in minutes) of each cow.

Statistical analysis

The energy corrected milk yield (ECM) was obtained by the equation: ECM = (0.327 * MY) + (19.95 * F * MY / 100) + (7.65% P * MY / 100), where, MY = milk yield in l/day, F = fat percentage and P = protein percentage (Tyrrell; Reid, 1965). For the variance analysis, we used the MIXED procedure of the SAS (SAS 2002) statistical package after testing the data for normality of the residuals by the Kolmogorov–Smirnov test and the homogeneity of the variances using the Levene test. The first variance analysis model (model 1) included the fixed effects genetic group, period (pre/postpartum), and the interaction between them. With model 1 we aimed to show the differences pre and postpartum and the possible interaction of the period with the genetic groups. The variables analyzed were DMI, DMI to BW (%), BCS, BW, BHB, and rumination time. In a second model (model 2), for the analyses of milk yield and quality (ECM, Fat (%), Protein (%), Lactose (%), Fat+Protein yield (kg)), and to further analyze DMI, BHB, BCS, and BW, we included the week relative to calving as a fixed effect instead of the pre/postpartum. With the second model, we aimed to demonstrate the weekly variation of the variables. By investigating possible interactions of the genetic group and week, we can demonstrate if the weekly variation of the variables is similar between the genetic groups. In all analyses a probability value less than 0.05 was considered statistically significant (P < 0.05).

Results

Holstein and crossbred Holstein x Simmental cows had similar DMI (P = 0.46; Table 2). There was a difference between pre and postpartum DMI (P < 0.01) with a higher value after calving. Both genetic groups reduced the DMI in the week prior to calving (Figure 1A). After calving, the DMI increased quickly (model 2). We observed an interaction between genetic group and period (P = 0.0074, model 1). The Holstein x Simmental cows had a higher DMI than purebred Holsteins in the third week after calving (Figure 1A, model 2). Conversely, the DMI proportion to BW (in %) did not differ between Holstein and Holstein x Simmental crossbred cows (P = 0.96; Table 2). There was no interaction between the genetic group and period (P = 0.14; model 1). There was also no difference in rumination time between the genetic groups (P = 0.41).

Crossbred Holstein x Simmental cows had a higher BCS than Holstein cows (P < 0.01; Table 2). This difference was observed in both periods (pre and postpartum) (model 1). Furthermore, we found an interaction between genetic group and week (P = 0.0016, model 2). The BCS decreased in both genetic groups after parturition, but the BCS decrease stopped earlier for crossbred Holstein x Simmental cows (Figure 2A, model 2). Both genetic groups showed a similar BW (P = 0.51; Table 2, model 1). Both genetic groups started to lose weight at week 1 prior to calving (Figure 2B, model 2). There was an interaction between the genetic group and the transition period (P = 0.04). The BW difference between the genetic groups was approximately 30 kg per cow after calving (model 1).

For the variable BHB, we observed a significant difference for the period (P < 0.01) with lower values prepartum for both genetic groups (model 1). After calving, the BHB concentration increased to more than 1 mmol/liter (Figure 1B, model 2). There was no interaction between the genetic group and transition period (P = 0.23, Table 2, model 1), and between the genetic group and week (P = 0.88, Table 3, model 2).

Table 2. Least Squares Means (±SEM) and results of the variance analysis (P-values) comparing genetic group (GG), period (prepartum and postpartum), and their interaction for the variables of dry matter intake (DMI), body weight (BW), body condition score (BCS), rumination time (RT), and β-hydroxybutyrate (BHB) for purebred Holstein (H) and F1 Holstein x Simmental (H x S) crossbred cows (model 1).

| Variable                  | Prepartum | Postpartum |
|---------------------------|-----------|------------|
|                           | H         | H × S      | GG | Period | GG × Period |
|                           | Mean ± SEM| Mean ± SEM | P-value | P-value | P-value |
| DMI (kg/day)              | 9.2 ± 0.5 | 9.3 ± 0.5  | 15.8 ± 0.5 | 16.9 ± 0.6 | 0.463 | <0.0001 | 0.007 |
| DMI of Body Weight (%)    | 1.3 ± 0.10| 1.2 ± 0.14 | 2.6 ± 0.07 | 2.7 ± 0.10 | 0.966 | <0.0001 | 0.146 |
| BCS                       | 3.99 ± 0.11| 4.13 ± 0.15| 2.86 ± 0.10| 3.64 ± 0.13| <0.0001 | <0.0001 | 0.131 |
| Body Weight (kg)          | 745 ± 18 | 750 ± 222 | 629 ± 17 | 659 ± 21 | 0.516 | <0.0001 | 0.040 |
| BHB (mmol/l)              | 0.74 ± 0.12| 0.78 ± 0.16| 1.39 ± 0.11| 1.17 ± 0.13| 0.577 | <0.0001 | 0.233 |
| RT (minutes/day)          | 478.7 ± 14.5| 471.4 ± 18.4| 552 ± 14.1| 529.7 ± 17.4| 0.509 | <0.0001 | 0.252 |
Holstein cows and crossbred Holstein x Simmental cows yielded similar amounts of milk ($P = 0.60$; Table 3). Both genetic groups produced approximately 21 liters/day from the day after calving. During the following days, the milk production increased quickly until reaching amounts around 34 liters/day in the third week after calving. Genetic groups did not differ in the protein and lactose content within the milk ($P = 0.64$ and $P = 0.83$, respectively). Conversely, crossbred Holstein x Simmental cows tended to produce milk with higher percentages of fat content ($P = 0.06$).

**Discussion**

We did not find any difference in the BHB concentration, ECM yield, DMI, and BW between Holstein and crossbred Holstein x Simmental cows during the experimental period. This result suggests the energy status of both genetic groups is similar. Hazel et al. (2013) compared Holstein and crossbred Holstein x Montbeliarde cows and found no difference between the genetic groups for DMI during the first 150 days of lactation. In the same study, crossbred cows produced 96% of the total milk compared to Holstein cows, similar to the yield of the cows in our study (94.5%). The observation of equal DMI in our study may relate to the production of similar amounts of milk combined with an identical milk composition (when measured as ECM). Both genetic groups in our study had similar BW. Therefore, it can be expected that cows of both genetic groups had similar maintenance requirements for energy and nutrients. Depending on the body composition BW of the genetic groups, the nutrient requirements may differ, which might affect the DMI. By comparing Holstein with Jersey cows or Holstein with crossbred Holstein x Jersey cows, Palladino et al. (2010) and Prendiville et al. (2011) demonstrated that the heavier purebred Holstein cows consume more dry matter than the lighter purebred Jerseys or crossbred cows, respectively.

DMI increases as milk yield increases after calving (Weber et al. 2013). The cows almost doubled their DMI by 21 days after calving, starting with approximately 9 kg/day after calving and reaching almost 18 kg/day by day 21 postpartum (Table 2, Figure 1A). The time pattern was similar for DMI in relation to BW (%) in both genetic groups. At the week before calving, cows had a DMI to the BW of approximately 1.2%. This value had more than doubled and reached values close to 3% of the BW by the third week of lactation. The increasing relative DMI is not only related to the increased demand for nutrients after calving. It increased more than the absolute DMI because the cows lost weight after calving (Table 2, Figure 2B) as a consequence of the negative energy balance (NEB) (Carvalho et al. 2014; Esposito et al. 2014). It is interesting to note that at 21 days after calving the cows had almost reached 3% DMI of BW. This value is similar to the values recommended for high yielding dairy cows (NRC 2001).

Even with similar DMI, crossbred Holstein x Simmental cows had a better BCS during the pre and postpartum periods than the purebred Holsteins (Table 2, Figure 2A). The more favourable BCS seems to be closely related to the complementarity between the breeds used in the crossbreeding programmes. Simmental is a dual-purpose breed, which has a higher BCS than purebred Holstein cows (Sgorlon et al. 2015; Schweizer 2020). In our study, Holstein cows lost approximately 0.6 BCS points in the three weeks after calving, while the crossbred Holstein x Simmental cows lost approximately 0.4 BCS points. Mlynek et al. (2018) have also shown that Simmental cows decline less in BCS after calving than Holstein cows. We did not find a difference in the BW between breeds (Table 2, Figure 2B). Both genetic groups lost approximately 100 kg of BW during the first three weeks of lactation. These values represent 12% and 15% of the BW for crossbred Holstein x Simmental cows and Holstein cows, respectively. The reduction in BW began in week 1 prior to calving, possibly due to the reduced DMI, which can amount to 30% (Dewhurst et al. 2000). A reason for these differences in BW between pre and postpartum may be related to the calving day itself, because at birth cows lose the calf weight and all the fluids originating from the uter (at a minimum). For our two genetic groups, the calf weight represents on average 45 kg (Knob et al. 2016). Furthermore, BW and BCS loss are related to NEB during the first three weeks of lactation, while the energy requirement for milk production is higher than the DMI can provide (Mann et al. 2016; Barletta et al. 2017; Djoković et al. 2017; Youssef and El-Ashker 2017).

Our results suggest the genetic group did not affect BHB, because both genetic groups had similar milk yields and DMI (Tables 2 and 3). BHB is closely correlated with NEB, being a marker of oxidation of mobilized fat by the liver (Zachut et al. 2020). During NEB (partly characterized by lipomobilization) excess NEFA are converted to acetoacetate which is mainly metabolized to BHB and to a lower extent into acetone to maintain the energy homeostasis for milk production (Barletta et al. 2017; Bruckmaier and Gross 2017; Djoković et al. 2017; Youssef and El-Ashker 2017). An important factor regulating the calcium and energy homeostasis during the transition period – as most challenging and critical time in relation to the dairy cow’s health status during the lactation cycle – is serotonin, which acts independent of the parathyroid hormone (Hernández-Castellano et al. 2017). A treatment with 5-hydroxytryptophan (the immediate precursor to serotonin synthesis) could actually decrease the BHB concentration at days 6–10 postpartum, what might lead to a more stable energy homeostasis, particularly in Jersey cows (Weaver et al. 2017). By comparing Holstein with crossbred Holstein x Jersey cows at two weeks before and eight weeks after calving, Pelizza et al. (2019) did, however, not find any difference between the breeds for BHB. They reported a difference between transition periods with higher BHB values after calving. No difference between breeds was also reported by Sgorlon et al. (2015) when comparing BHB between Holstein and Simmental cows in Italy. In contrast, Lopreiato et al. (2019) found that Simmental cows had lower BHB values, possibly due to the lower milk yield when compared to Holstein cows. Although, genetic groups did not differ, both of them reached BHB values higher than 1.1 mmol/l at the third week after calving, indicating a high use of body reserves to supply the energy requirements because of the high (and increasing) milk yield. Contrary to these observations, elevated BHB concentrations in combination with increased NEFA values are associated with a reduced milk yield (Zachut et al. 2020). One reason for the
The difference between the own results and the statement made in the review by Zachut et al. (2020), might be that the severity of the effects of elevated BHB varies depending on DIM at the onset of hyperketonemia’ (Santschi et al. 2016). Because our study stopped after the third week of lactation, we can only speculate that cows with an elevated level of

Figure 1. Weekly means of dry matter intake (A) and beta-hydroxybutyrate (BHB) (B) at three weeks before calving to three weeks after calving for purebred Holstein (H) and crossbred Holstein x Simmental cows (H x S) – results (LSM ± SEM) of variance analysis model 2.
BHB would show a relatively lower (or decreasing) milk yield during the following weeks of lactation in comparison to cows with a normal level of BHB.

The difference between transition periods with higher rumination times after calving is possibly related to a higher DMI after calving (Table 2). Cows spent approximately 51 min ruminating for each Kg of DMI before calving. After calving, these values decreased to approximately 32–34 min for each Kg of DMI. This difference may be related to the different diets offered to the cows during the prepartum and postpartum periods.

**Figure 2.** Weekly means of body condition score (BCS) (A) and body weight (B) from three weeks before calving to three weeks after calving for purebred Holstein (H) and crossbred Holstein x Simmental (H x S) cows – results (LSM ± SEM) of variance analysis model 2.
periods. The amount of concentrate offered to the cows increased from around 27% of the prepartum diet to 40% of the DM in the postpartum diet (Table 1). The ingredients of the concentrate ration undergo rapid degradation in the rumen and do not favour rumination, because of the lower fibre content (Kargar et al. 2010). Besides a lower DMI (especially during the week just before calving), other factors contributing to the lower rumination time (especially on the day before and at the calving day) are the birth mechanisms and body changes involved in calving. Schirmann et al. (2013) observed a reduction of 60 min rumination time and 3.8 kg DMI 24 h before calving. Between 24 and 48 h after calving, the rumination time returns to the same values prior calving.

Both genetic groups produced similar amounts of milk during the first three weeks of lactation (Table 3). Similar or a little lower milk yields for crossbred cows have been reported in other studies that covered the entire lactation (Brähmig 2011; Knob et al. 2018; Nolte 2019). Generally, the milk yield increased quickly during the first week of lactation, starting at about 21 litres on the day of calving to close 30 litres/day after seven days of lactation. By lactation day 21, both genetic groups had a milk yield close to 40 liters/day; they had doubled their milk yield during this time. Additionally, the fat and protein content did not vary between the genetic groups. Both variables decreased from the first until the third week after calving. This is possibly due to the dilution effect as the amount of milk produced doubled during the same period.

One of the limitations of our study is the relatively small number of animals, especially regarding the crossbred Holstein x Simmental cows. This led to a relatively low power (1- beta error) of 0.67 for the statistical analysis. We think, however, that the results of our study are relevant and provide new insights into the transition period of crossbred Holstein x Simmental cows compared to Holstein cows.

### Disclosure statement

No potential conflict of interest was reported by the author(s).

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**Table 3. Genetic Group least squares means (±SEM) and results of the variance analysis (P-values) for Genetic Group (GG), week relative to calving, and their interaction for the variables related to milk yield and milk composition, dry matter intake (DMI), body weight (BW), body condition score (BCS), rumination time (RT), and beta-hydroxybutyrate (BHB) for purebred Holstein and F1 Holstein x Simmental crossbred cows (model 2).**

| Variable                                      | Genetic group | P-value |
|-----------------------------------------------|---------------|---------|
|                                               | H             | H × S   | GG     | Week       | GG×Week |
| Milk yield (l/day)*                           | 30.8 ± 1.8    | 29.3 ± 2.3 | 0.603  | 0.002      | 0.498   |
| ECM**                                        | 38.2 ± 1.9    | 36.5 ± 1.6 | 0.519  | 0.421      | 0.548   |
| Fat (%)                                      | 3.39 ± 0.13   | 4.48 ± 0.21 | 0.068  | 0.002      | 0.460   |
| Protein (%)                                  | 3.31 ± 0.07   | 3.37 ± 0.1  | 0.644  | 0.002      | 0.089   |
| Lactose (%)                                  | 4.57 ± 0.03   | 4.58 ± 0.06 | 0.832  | 0.0004     | 0.368   |
| Fat + Protein yield (kg)                     | 2.54 ± 0.09   | 2.45 ± 0.15 | 0.662  | 0.705      | 0.662   |
| DMI (kg/day)                                 | 12.3 ± 0.48   | 12.8 ± 0.59 | 0.571  | <0.0001    | 0.072   |
| DMI of Body Weight (%)                       | 1.87 ± 0.03   | 1.77 ± 0.05 | 0.103  | <0.0001    | 0.634   |
| BCS                                          | 3.26 ± 0.09   | 3.90 ± 0.12 | <0.0001| <0.0001    | 0.002   |
| Body Weight (kg)                             | 688 ± 17      | 707 ± 21   | 0.500  | <0.0001    | 0.147   |
| BHB (mmol/l)                                 | 0.96 ± 0.07   | 0.88 ± 0.09 | 0.554  | 0.0005     | 0.880   |
| RT (minutes/day)                             | 516 ± 13.5    | 498 ± 17   | 0.410  | <0.0001    | 0.636   |

*The results for milk yield and milk composition were sampled 3 weeks after calving. All other variables include the observations prepartum and postpartum (were sampled 6 weeks post calving).

**ECM = Energy corrected milk yield.**

**Table 3. Genetic Group least squares means (±SEM) and results of the variance analysis (P-values) for Genetic Group (GG), week relative to calving, and their interaction for the variables related to milk yield and milk composition, dry matter intake (DMI), body weight (BW), body condition score (BCS), rumination time (RT), and beta-hydroxybutyrate (BHB) for purebred Holstein and F1 Holstein x Simmental crossbred cows (model 2).**

### Conclusion

After three weeks of lactation, DMI, milk yield, and all the other parameters keep changing. This study, however, demonstrates how the two different genetic groups (Holstein and crossbred Holstein x Simmental) handle the challenging transition period. Both genetic groups had a similar energy requirement prior and post calving. We have successfully demonstrated that the crossbreeding programme with Simmental semen, results in no negative effect on performance during the transition period in Holstein herds. The crossbred cows had the same dry matter intake and milk yield, and presented better body condition scores than purebred Holsteins. Crossbreeding between Holstein and Simmental might have a positive effect on the reproductive performance and lactation curve (persistency).
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