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Investigating genotype by supplementation interaction in an Alpine low-input dairy system

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Abstract. Two contrasting dairy cow types were compared at two different concentrate supplementation levels in an Alpine low-input dairy system. The two genotypes were conventional Brown Swiss (BS) and a specific strain of Holstein Friesian (HFL). The latter was primarily selected for lifetime performance and fitness under low-input conditions. Both genotypes were assigned to one of two concentrate supplementation levels, receiving 635 kg (C) or 277 kg (L) of concentrates per lactation. Until Dec. 2013, 19 and 26 lactations were completed for BS and HFL, resp., and were analysed using a mixed model. There was no evidence for a significant breed by supplementation interaction. Milk and milk solid yields were significantly lower in the L treatment for both breeds, but no significant difference was observed for body condition score or reproductive performance between breeds or supplementation level.

Keywords. Dairy cattle – Pasture – Seasonal – Breed – Supplementation level.

Evaluation de l'interaction génotype x complémentation dans un système d'élevage alpin de vaches laitières à faible niveau d'intrants

Résumé. *Deux types très différents de vaches laitières ont été comparés pour deux niveaux de complémentation en concentrés au sein d'un système d'élevage alpin à faible niveau d'intrants. Les deux génotypes consistaient en la race conventionnelle Brune des Alpes (BS) et une souche spécifique de Holstein Friesian (HFL). Cette dernière a été sélectionnée principalement pour sa longévité et sa capacité d'adaptation à des conditions de bas niveau d'intrants. Les génotypes ont été assignés à un des deux niveaux de supplémentation, recevant 635 kg (C) ou 277 kg (L) de concentrés par lactation. En décembre 2013, 19 et 26 lactations avaient été menées à terme par BS et HFL respectivement. Les données ont été analysées au moyen d'un modèle mixte. Aucune interaction significative entre la race et la supplémentation n'a été détectée. Les rendements en lait et en matière sèche étaient significativement plus bas pour les deux races dans le cas du traitement L. En revanche, aucune différence significative n'a été observée pour la note d'état corporel ou la performance reproductive entre les races ou entre les niveaux de supplémentation.*

Mots-clés. Bovins laitiers – Pâturage – Saisonnier – Race – Niveau de complémentation.

I – Introduction

The technical performance and the economic competitiveness of organic and low input dairy systems depend, among other factors, on the suitability of genotypes for a given environment. Recent studies from Alpine regions indicated that different cow types are likely to differ in their suitability for Alpine pasture-based, seasonal low-input dairy systems (Horn *et al*., 2013; Piccand *et al*., 2013). The aim of the present study was to compare the impact of a reduction in concentrate supplementation level on two different dairy cow types within such an Alpine low-input system.

II – Materials and methods

The study was carried out between October 2011 and January 2014 at the experimental organic dairy farm of the Agricultural Research and Education Centre Raumberg-Gumpenstein, Trautenfels, Austria (680 m altitude, 7°C average temperature; 1,014 mm [±63] precipitation year^{-1}).

The two genotypes compared were conventional Austrian Brown Swiss (BS) and a specific strain of Holstein Friesian (HFL). Compared to the Austrian BS population genetic merits of the BS animals included in the study were slightly below average for milk production and slightly above average for fitness. HFL was selected for superior lifetime milk yield and fitness in an alternative breeding programme and was mostly managed under lower input conditions. A detailed description of both genotypes can be found at Horn *et al*. (2013). Until December 2013 data of 19 lactations of 12 individual BS cows and 26 lactations of 18 individual HFL cows were collected.

The two genotypes were assigned to one out of two dietary treatments which differed in concentrate supplementation level (control [C] and low [L]; 11, 10, 14 and 14 lactations in groups BS C, BS L, HFL C and HFL L, resp.). During the barn feeding period both treatments were fed 4.4 kg DM/d of hay and had free access to grass silage. For C daily concentrate supply increased from 2 to 7.5 kg DM from day 1 to 21 in milk (DIM), resp. Between 21 – 35 DIM concentrate supply was maintained at 7.5 kg. Afterwards it depended on milk yield, with cows yielding more than 16 kg receiving 0.5 kg DM of concentrate for every additional kg of milk yield, but with an upper limit of 7.5 kg DM/day. Animals had free access to a continuously grazed sward between Apr. 3 and Oct. 27 and between Apr. 8 and Nov. 5 in experimental years 1 and 2, resp. During the grazing season only animals yielding more than 24 kg received 0.5 kg DM of concentrate for every additional kg of milk yield in the C treatment. The amount of concentrate was reduced by 50% for group L as compared to group C during the whole study period, but formulation and supplementation pattern was the same for both groups.

During the two years of the study calvings took place between Oct. 10 and Feb. 18 and Sep. 26 and Feb. 27, resp. Cows were artificially inseminated at the earliest after 30 DIM.

Individual milk yield was recorded twice daily and milk contents were analysed three times a week. Animals were weighed weekly and body condition scoring (BCS, 5 point scale) was done fortnightly. During the barn feeding period individual rations were provided in calan gates. Feedstuffs were sampled monthly and the results of the chemical analysis are given in Table 1.

Table 1. Nutrient and energy content of grass silage, hay, concentrate and pasture

	Grass silage	Hay	Pasture	Concentrate
DM (g/kg FM)	365 (45.3)†	833 (28.9)	170 (18.2)	866 (9.4)
XP (g/kg DM)	145 (13.1)	135 (11.4)	220 (24.4)	138 (11.4)
NDF (g/kg DM)	458 (31.7)	498 (37.2)	413 (34.2)	189 (26.8)
ADF (g/kg DM)	304 (18.1)	303 (16.0)	259 (29.2)	67 (11.0)
NEL (MJ/kg DM)	6.1 (0.18)	5.6 (0.13)	6.6 (0.29)	8.0 (0.04)

† Standard deviation in brackets.

The data were analysed using a mixed model (SAS 9.1), including the fixed effects of breed (BS and HFL), supplementation level (C and L), year (1 and 2), lactation (primiparous or multiparous) and the interaction of breed and supplementation. To correct for different calving dates during the barn feeding period, the DIM at turn out to pasture was included as a continuous co-variable. Furthermore the animal was included as a random effect and week of lactation was the factor for which measurements were repeated (auto-regressive co-variance structure). Wilcoxon rank-sum test was used to analyse the number of services per cow. Significance was defined at P = <0.05 and the results are presented as least square means and residual standard deviations (s_e).

III – Results and discussion

The results of selected traits of productivity, body weight, body condition and reproductive performance are presented in Table 2. No significant interaction between breed and supplementation level was observed for any of the traits. As intended, the total concentrate supplementation differed (*P* = <.001) between dietary treatments and was 635 and 277 kg for the C and L, respectively. While length of lactation was not influenced by breed or treatment, milk yield (*P* = 0.012) and milk solid yield (*P* = 0.008) were higher for C compared to L. There tended to be a significant interaction of breed and treatment for fat content (*P*=0.095), which stayed relatively stable for BS, while it increased for HFL when comparing C and L. Protein contents were not influenced by treatment but tended to be higher for BS than for HFL. No differences between breeds or treatments were observed for energy-corrected milk yield per kg of metabolic body weight and somatic cell count. BS was heavier throughout lactation (*P* = 0.006), while treatment did not affect mean body weight. There were no significant differences between breeds or treatments for BCS at nadir, but BCS at calving was significantly higher for BS than for HFL. Neither days to conception nor number of services per conception were significantly influenced by breed or treatment.

Table 2. Influence of breed and supplementation level on selected traits of productivity, body weight, body condition score and fertility

	BS		HFL		s_e	P_{breed}	$P_{suppl.}$	$P_{breed×suppl.}$
Trait	**Control**	**Low**	**Control**	**Low**				
Concentrate consum., kg	664	273	602	282	141.1	0.569	<.001	0.430
Lactation length, d	312	297	296	288	26.6	0.243	0.234	0.617
Milk yield, kg	6,235	5,537	5,802	5,343	573.7	0.390	0.012	0.538
Milk solid yield, kg	456	396	419	388	42.0	0.376	0.008	0.320
Fat content,%	4.13	4.11	4.29	4.44	0.901	0.031	0.248	0.095
Protein content,%	3.45	3.39	3.31	3.29	0.195	0.095	0.122	0.458
ECM yield/kg $BW^{0.75}$, kg/d	0.14	0.13	0.15	0.14	0.032	0.249	0.153	0.707
Somatic cell count, n/ml	82,313	75,238	101,660	95,764	27,479	0.164	0.414	0.941
Body weight, kg	602	608	549	551	40.5	0.006	0.743	0.866
BCS at calving	3.41	3.45	3.13	3.27	0.313	0.020	0.333	0.563
BCS at nadir	2.29	2.26	2.28	2.30	0.179	0.862	0.931	0.673
Days to conception, d	79	68	81	78	33.9	0.646	0.539	0.708
Services per conception, n	1.6	1.4	1.4	1.6	–	0.861	0.893	–

Varying responses to concentrate supplementation between dairy cows with different genetic merits were reported previously (Yan *et al*., 2006). Comparing milk yields during lactation and concentrate consumptions, milk yield increased by 1.8 kg and 1.4 kg per additional kg of concentrate for BS and HFL, respectively, which is slightly higher than reported by Delaby *et al*. (2009). The higher conversion efficiency might be explained by the differences in supplementation strategies, as in the present studies cows were mainly supplemented during the first third of lactation. However, in contrast to the study of Horan *et al*. (2005) neither in the present paper nor in the study of Delaby *et al*. (2009) a significant interaction between genotype and supplementation level for milk and milk solid yield over the entire lactation could be found. This might be explained by the smaller differentiation of supplementation in the present study as compared to Horan *et al*. (2005), 356 kg versus 950 kg of concentrates, respectively, as the presence or absence of a genotype by environment interaction mainly depends on the degree of difference between genotypes or environments (Hammami *et al*., 2009). The slightly higher protein content of BS compared to HFL was reported in a previous study comparing both genotypes in a pasture based dairy system and reflects the different selection focus (Horn *et al*., 2013). In contrast, the higher fat content of HFL, especially in the L treatment, does neither agree with the genetic predisposition of HFL nor with the results of the study mentioned above. A slightly higher body condition of BS compared to Holsteins under predominantly grazing condition was already reported by Piccand *et al*. (2013) as well as the lack of an interaction between breed and supplementation level for other body condition variables by Delaby *et al*. (2009). The lack of influence of concentrate supplementation on the course of body condition score seems to be in agreement with the comparable reproductive performances in both treatments. However, the similar reproductive performance does not reflect the breed differences in genetic merit for fertility. Compared to an earlier study, reproductive performance of HFL was observed on a similar level, while a considerably longer calving to conception interval was reported for BS (Horn *et al*., 2013). However, due to the relatively low number of animals conclusions on reproductive performance must be done with caution.

IV – Conclusions

There were no significantly different reactions to the reduction of concentrate supplementation observed for the both genotypes compared. This might be due to the relatively small differences between supplementation levels in the present work, compared to other studies with a similar scope. However, the results indicate that the reduction of concentrate supplementation in a pasture based milk production system does not necessarily have a negative impact on the course of body condition score.

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