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Body and milk quality traits of purebred Holstein and three-generation crossbred cows from Viking Red, Montbéliarde, and Holstein sires

Sudeb SAHA*, Luca CARRARO, Giovanni BITTANTE and Luigi GALLO

Department of Agronomy, Food, Natural Resources, Animals and Environment, University of Padova, Italy, *correspondence: sudeb.saha@studenti.unipd.it

Abstract

The objective of this study was to investigate the effects of 3-way rotational crossbreeding scheme of Holstein (HO) cows with Montbéliarde (MO), Viking Red (VR) and HO sires on body and milk quality traits. Cows were purebred HO; F1: (MO × HO; VR × HO); F2: [MO × (VR × HO); VR × (MO × HO)]; F3: {HO × [MO × (VR × HO)]}; HO × [VR x (MO × HO)]}. Data were collected on 745 cows kept in a commercial farm located in Northern Italy. Milk data were acquired from official milk recording and body condition score (BCS) and conformation traits were measured once by trained evaluator. Data were analyzed using a linear model including fixed effects of parity, DIM class and breed combinations. Average body traits: height at withers (HW), body length (BL) and heart girth (HG) of cows were 139,162 and 207 cm respectively. Crossbred cows had shorter HW, BL and HG than pure HO but greater BCS. Milk yield averaged 31.5 kg/d, with fat and protein content close to 3.8 and 3.75%, respectively. Purebred HO produced greater volume of milk than crossbreds but milk from HO had lower protein content. Different combinations of crossbred cows showed similar performance in terms of milk yield traits, but evidenced different body size. The trial is currently in progress to increase cow sample size and widen the number of herds involved.

Keywords: body size, crossbreeding, dairy cows, Holstein, milk composition, milk yield, Montbéliarde, Viking Red

Introduction

Crossbreeding in dairy cattle has become of interest because of declining fertility, health and survival of purebred Holstein (HO) cows, the dominating single breed in most dairy herds (Hazel et al., 2017a; Saha et al., 2017). Crossbreeding of HO cows with proper breeds may also improve the fat and protein content and some technological attributes of milk (Malchiodi et al., 2014). For these reasons, crossbreeding has become a significant breeding strategy in different developed and developing countries.

Holstein has been selected for a long time for improved milk yield and large frame size (Hazel et al., 2017b). This may have negatively influenced health and fertility status of the animals. Further, large frame body size requires more maintenance cost because of reduced feed efficiency (VandeHaar et al., 2016). Thus, the interest in crossbreeding HO cows with Montbéliarde (MO) and Viking Red (VR) has increased in recent years because these breeds have been selected for improved health traits (Hazel et al., 2017b) and alongside production milk solids (Hazel et al., 2017a). Reports of body conformation and milk composition traits for MO and VR sire crossbred cows are sparse; nearly most of the dairy producers focus attention on body conformation, milk yield and composition. Thus, the objective of this research was to analyze the effects of 3-way rotational crossing of HO dam with VR, MO and HO sires on body conformation, milk yield (MY) and composition traits of crossbred dairy cows.

Materials and methods

The study involved 745 cows kept in a commercial farm of northern Italy managed according to the rules of Parmigiano Reggiano cheese and following a 3-way rotational crossbreeding program (ProCross, Genesi Project Srl, Italy) based on the use of VR, MO and HO bull semen, as shown in Table 1.

Table 1. Three-way crossbreeding program used in the farm

Breeds combination	Sire		Dam
Purebred	Holstein (HO)	×	HO
First cross (F1)	Montbéliarde (MO)	×	HO
	Viking Red (VR)	×	HO
Second cross (F2)	MO	×	VRHO
	VR	×	MOHO
Third cross (F3)	HO	×	MOVRHO
	HO	×	VRMOHO

Cows were evaluated for body condition score (BCS) by one skilled operator based on a scale from 1 (very thin) to 5 (very fat) with 0.25 increments. Height at withers (HW) and body length (BL) were taken using a measuring stick from the floor to the highest point of the withers and from the scapular joint to the pin bone, respectively. Heart girth (HG) was taken using a tape behind the front legs and shoulder blades. MY and quality traits data were obtained from the official milk recording system.

Prior to the statistical analysis cows were categorized for parity (primiparous and multiparous) and days in milk (DIM, 5 classes of 60-d each from <60 to >240 DIM), and genetic combination, as shown in table 1. Data were analyzed by using PROC GLM procedure of SAS to conduct ANOVA where parity, DIM and breeds combination were the fixed effects. Orthogonal contrasts were estimated between the least square means of different breed combinations to compare: 1) purebred HO vs other crossbred cows; 2) F1 cows against F2 + F3 cows; 3) VR against MO sire in F1; 4) F2 vs F3 cows; 5) VR against MO sire in F2 cows; 6) the two different breed combinations within F3 crossbred cows.

Results and discussion

BCS averaged 3.2 (Table 2) and was lower in purebred HO than in crossbred cows, in agreement with results of Hazel et al. (2017b) and Walsh et al. (2008). Similarly, F2 cows had higher BCS than F3 cows. Additionally, MO × HO had higher BCS compared to VR × HO cows. Also, Hazel et al. (2017b) reported that MO × HO had increased BCS than VR × HO, but the scale of difference was greater than that of the current study. The reason for this may be different feeding, environmental and farming conditions.

Average HW and HG found in the present study for purebred HO were comparable with the figures reported for HO cows by Hazel et al. (2017b) and Gallo et al. (2017). Purebred HO had greater body size than crossbred cows, and this is consistent with the results of Hazel et al. (2017b). Within F1 generation, VR × HO had slightly lower HW and notably reduced HG than MO × HO (Table 2), and again these findings are consistent with data of Hazel et al. (2017b). Last, F3 cows had lower BCS and greater HW and HG than F2 generation, probably because of greater percentage of HO gene in F3 than in F2 generation.

MY (Table 3) averaged 31.5 kg/d, whereas fat and protein content were 3.8 and 3.75%, respectively.

In this study, purebred HO yielded greater volume of milk than crossbred cows. Even if milk from HO was characterized by lower content of protein, the superiority of HO in MY was enough to provide greater fat+protein daily production with respect to crossbred cows. No difference among crossbred cows was found for MY and fat and protein content of milk. The SCS did not differ for pure HO and crossbreds and even within the crossbred cows. Recently, Hazel et al. (2017a) found that purebred HO cows produced nearly 2% more milk than MO × HO and VR × HO crossbred cows, but lower fat and protein content during first lactation. Conversely, Saha et al. (2017) did not find any significant difference in MY, fat and protein content between pure HO and F1 and F2 generation crossbred cows.

Table 2. Least squares mean and standard error of BCS and body conformation traits across breed combinations

Breeds combination	Cows no	BCS	Height at withers, cm	Body length, cm	Heart girth, cm
HO × HO	277	3.08±0.02	142±0.3	163±0.45	208±0.61
F1:					
- MO × HO	112	3.37±0.03	137±0.46	160±0.68	208±0.92
- VR × HO	48	3.25±0.04	136±0.62	160±0.91	203±1.23
F2:					
- MO × (VR × HO)	53	3.42±0.08	134±1.09	160±1.6	205±2.18
- VR × (MO × HO)	75	3.36±0.04	134±0.53	160±0.78	201±1.06
F3:					
- HO × [MO × (VR × HO)]	139	3.3±0.03	139±0.42	161±0.62	207±0.84
- HO × [VR × (MO × HO)]	41	3.27±0.05	139±0.71	161±1.04	207±0.92
Contrast, P-value[1]					
HO × HO vs (F1+F2+F3)		<0.001	<0.001	<0.001	<0.001
F1 vs (F2+F3)		NS	NS	NS	NS
Within F1		0.04	0.03	NS	<0.001
F2 vs F3		<0.05	<0.001	NS	0.01
Within F2		NS	NS	NS	NS
Within F3		NS	NS	NS	NS

[1]NS = P value of the contrast >0.1
HO: Holstein; MO: Montbéliarde; VR:Viking Red

Table 3. Least squares mean and standard error of milk yield and quality across breed combinations

Breeds combination	Milk yield (kg/d)	Fat (%)	Protein (%)	Fat + Protein (kg)	SCS
HO × HO	32.3±0.51	3.76±0.05	3.67±0.02	2.37±0.03	2.38±0.12
F1:					
- MO × HO	29.5±0.74	3.84±0.07	3.74±0.03	2.2±0.05	2.45±0.18
- VR × HO	29.7±1.12	3.96±0.11	3.8±0.04	2.28±0.08	1.94±0.27
F2:					
- MO × (VR × HO)	30.1±1.81	3.83±0.18	3.71±0.07	2.25±0.13	1.67±0.43
- VR × (MO × HO)	28.4±0.92	3.94±0.09	3.76±0.03	2.14±0.06	2.44±0.22
F3:					
HO × [MO × (VR × HO)]	30.5±0.73	3.71±0.08	3.71±0.03	2.23±0.05	2.02±0.18
HO × [VR × (MO × HO)]	29.5±1.2	3.66±0.12	3.67±0.04	2.14±0.08	2.31±0.29
Contrast, P-value[1]					
HO × HO vs (F1+F2+F3)	0.002	NS	0.02	<0.001	NS
F1 vs (F2+F3)	NS	NS	NS	NS	NS
Within F1	NS	NS	NS	NS	NS
F2 vs F3	NS	NS	NS	NS	NS
Within F2	NS	NS	NS	NS	NS
Within F3	NS	NS	NS	NS	NS

[1]NS = P value of the contrast >0.1
HO: Holstein; MO: Montbéliarde; VR: Viking Red

Conclusions

In this study, crossbred cows had shorter HW, BL and shallower HG than pure HO but greater BCS. Different body size may affect production efficiency of cows. In addition, crossbred cows produced milk with a greater content of protein, which is important to the dairy chain, particularly in those countries where cheese production

is prevalent. However, improved protein content does not compensate lower milk yield in crossbred cows. A full comparison of crossbreeding scheme would require further considerations about effects on health, fertility, longevity and production efficiency. The study is currently in progress to increase cow sample size and widen the number of herds involved and of traits taken into account.

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