Factors Affecting Linear Type Traits of Valdostana Cattle

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Summary

Four composite and 22 individual linear type traits, measured between 1997 and 2012 on 33,206 Aosta Red Pied (ARP) and 19,551 Aosta Black Pied and Aosta Chestnut (ABP-CN) strains of Valdostana cattle, were used to investigate the non-genetic factors affecting morphological evaluation. Average values for type traits ranged from 2.81 (teat placement rear view and foot angle) to 3.34 (thinness) for ARP, and from 2.48 (teat placement side view) to 3.67 (udder depth) for ABP-CN. Results from the ANOVA showed significant effect of herd-year-classifier on type traits of both ARP and ABP-CN, and of days in milk and age at calving for almost all traits, with few exceptions. The model used in this study is a useful starting point to calculate genetic parameters for Valdostana cattle.

Key words

Valdostana cattle, linear type traits, source of variation

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Aim

The Valdostana is an indigenous dual purpose Italian breed mainly raised in Valle d'Aosta region (northwest Italy). There are three strains of Valdostana cattle which differ in morphology characteristics, coat colour, production and temperament. One herd book is dedicated to the Aosta Red Pied strain (ARP), which is particularly docile and strong, very adapted to harsh climates and resistant to many pathogens. The second herd book is for the Aosta Black Pied and Aosta Chestnut strain (ABP-CN), characterised by lower milk production but more countrified and stronger than ARP. This strain is lively and quite aggressive and it is also selected for fighting ability (Sartori and Mantovani, 2010). Morphological evaluation is one of the selection tools used in many cattle breeds, as well as in the Valdostana cattle. Conformation traits have been recorded for years in many other breeds, for example in Holstein-Friesian (Meyer et al., 1987; Berry et al., 2004), Brown Swiss (Vukasinovic et al., 1997; Wiggans et al., 2006), and in some Italian indigenous breeds, such as Piemontese (Mantovani et al., 2010), Chianina, Marchigiana and Romagnola (Forabosco et al., 2005) and Rendena (Mantovani et al., 1997) cattle. The aim of the present study was to investigate the environmental factors associated with linear type traits in ARP and ABP-CN cattle.

Material and methods

Type traits data on animals scored between 1997 and 2012 were provided by the Italian National Valdostana Cattle Breeders Association (ANABORAVA) and included information on first and second parity cows Aosta Red Pied (ARP) and Aosta Black Pied and Aosta Chestnut (ABP-CN) strains. Type traits were scored on a 1- to 5- point scale, and consisted of four composite traits (body size, fleshiness, body shape and udder) and 22 individual type traits: 4 body size traits – stature, body length, thorax depth and thorax width; 4 fleshiness traits – front muscularity, back, loins and rump, thigh and buttocks side and rear view; 6 body shape traits – thinness, rump angle, width and length, rear legs and foot angle; 8 udder traits – fore and rear udder attach, udder width and depth, suspensory ligament, teat placement rear and side view, and teat length (Table 1). Records without an associated herd and classifier identification or missing observations for any of the linear type traits were discarded. Only records scored between 10 and 350 days in milk (DIM) were retained. Furthermore only first parity cows calving between 22 and 48 months of age and second parity cows calving between 38 and 60 months of age were retained. Age at first calving was grouped into 5 classes: 22 to 29 mo, 30 to 34 mo, 35 to 36 mo, 37 to 41 mo, and 42 to 48 mo. Age at second calving was also grouped into 5 classes: 38 to 41 mo, 42 to 46 mo, 47 to 48 mo, 49 to 53 mo, and 54 to 60 mo. Furthermore, DIM were categorised into 7 classes, the first being a class from 10 to 30 d, the central being classes of 30 d each, and the last being a class from 180 to 350 d. Only herd-year-classifier contemporary groups with at least 2 records were retained.

Following all edits, 33,206 ARP cows (32,371 primiparous and 835 secondiparous) and 19,551 ABP-CN cows (19,135 primiparous and 416 secondiparous) were available for statistical analysis.

A fixed effects model was used to investigate factors associated with composite and individual type traits using the PROC GLM of SAS (SAS, 2009).

The model was as follows:

$$y_{ijkl} = \mu + HYC_i + DIM_j + AGE_k + e_{ijkl},$$

where:

y_{ijkl} = linear type trait for cow l;
μ = population mean
HYC_i = fixed effect of herd-year-classifier (7,475 levels for ARP and 5,504 levels for ABP-CN);
DIM_j = fixed effect of days in milk (7 classes: the first being a class from 10 to 30 d, the central being classes of 30 d each, and the last being a class from 180 to 350 d;
AGE_k = fixed effect of age at calving (10 classes for both strains: 5 classes for first parity cows – from 22 to 29 mo, from 30 to 34 mo, from 35 to 36 mo, from 37 to 41 mo, and from 42 to 48 mo; and 5 classes for second parity cows – from 38 to 41 mo, from 42 to 46 mo, from 47 to 48 mo, from 49 to 53 mo, and from 54 to 60 mo);
e_{ijkl} = random residual effect.

Results and discussion

The majority of cows were scored between 91 and 120 days in milk (28.2% of records for ARP and 33.7% of records for ABP-CN) and between 121 and 150 days in milk (29.4% of records for ARP and 30.2% of records for ABP-CN). Most animals were between 35 and 36 months of age (47.7% of ARP and 56.4% of ABP-CN) at first calving and between 47 and 48 months of age (28.4% of ARP and 41.8% of ABP-CN) at second calving.

Descriptive statistics for all considered traits are summarised in Table 1. Mean values varied from 2.81 (teat placement rear view and foot angle) to 3.34 (thinness) in the ARP and from 2.48 (teat placement side view) to 3.67 (udder depth) in the ABP-CN. Greater variation, as determined by the standard deviation (SD), existed in the ARP compared to the ABP-CN; the largest SD was for fore udder attachment (0.97 for ARP and 0.91 for ABP-CN) while the smallest SD was for teat placement rear view in the ARP (0.65) and for foot angle in the ABP-CN (0.63). Analyzing the linear type trait scores, it was also observed a very low incidence of the extreme points of the scale system utilized by the classifiers, indeed the 1 point had an incidence of only 3.14% (ARP) and 3.91% (ABP-CN), while for the other extreme point of the scale (5 point) there was an incidence of 4.46% (ARP) and 4.09% (ABP-CN). A huge amount of the total incidence was found, instead, for the middle point of the scale (51.16% for ARP and 50.03% for ABP-CN). This means that there is the tendency of the classifiers to use most, and perhaps overly, the middle point of the scale, at the expense of the extreme points. Comparisons with other breeds are difficult since different scales are generally used. For example, Foster et al. (1989) and Misztal et al. (1992) used a 50-point scale in Holstein cows, as did Samoré et al. (2010) in Italian Brown Swiss cattle. Wall et al. (2005) used a 1 to 9-point scale for Holstein-Friesian cows. The same scale system was however used in Czech Holstein (Němcová et al., 2011) and Italian Piemontese beef cattle (Albera et al., 2001; Mantovani et al., 2010).

Table 1. Means and standard deviations of linear type traits

Trait	Type traits score 1	Type traits score 5	ARP[1] Mean (SD[3])	ABP-CN[2] Mean (SD[3])
Composite				
Body size	Undeveloped	Highly developed	3.08 (0.83)	3.19 (0.80)
Fleshiness	Poor	Excellent	3.01 (0.85)	3.31 (0.81)
Body shape	Fine	Heavy	2.97 (0.82)	3.10 (0.80)
Udder	Poor	Excellent	3.09 (0.88)	2.62 (0.81)
Individual				
Stature	Short	Tall	3.06 (0.91)	3.10 (0.86)
Body length	Short	Long	3.21 (0.88)	3.36 (0.86)
Thorax depth	Shallow	Deep	3.18 (0.79)	3.25 (0.76)
Thorax width	Narrow	Wide	2.93 (0.84)	3.19 (0.80)
Front muscularity	Scarce	Developed	2.87 (0.86)	3.29 (0.86)
Back, Loins and Rump	Scarce	Developed	2.94 (0.86)	3.21 (0.82)
Thigh, Buttock side view	Hollow	Rounded	3.06 (0.87)	3.35 (0.83)
Thigh, Buttock rear view	Hollow	Rounded	3.05 (0.89)	3.22 (0.84)
Thinness	Fine	Heavy	3.34 (0.92)	3.18 (0.84)
Rump angle	Back inclined	Forward inclined	3.05 (0.72)	2.89 (0.70)
Rump width	Narrow	Wide	3.19 (0.78)	3.20 (0.71)
Rump length	Short	Long	3.28 (0.81)	3.41 (0.77)
Rear legs	Straight	Sickle	3.04 (0.77)	3.05 (0.70)
Foot angle	Low	Steep	2.81 (0.69)	2.84 (0.63)
Fore udder attach	Weak	Strong	3.08 (0.97)	2.63 (0.91)
Rear udder attach	Low	High	3.23 (0.89)	2.59 (0.83)
Udder width	Narrow	Wide	3.23 (0.90)	2.59 (0.85)
Udder depth	Deep	Shallow	3.20 (0.80)	3.67 (0.85)
Suspensory ligament	Weak	Strong	2.97 (0.80)	2.76 (0.79)
Teat placement rear view	Diverging	Converging	2.81 (0.65)	2.68 (0.65)
Teat placement side view	Close	Far	2.91 (0.68)	2.48 (0.70)
Teat length	Short	Long	2.93 (0.76)	2.65 (0.81)

[1] ARP – Aosta Red Pied strain; [2] ABP-CN – Aosta Black Pied and Chestnut strain; [3] Standard deviation.

The phenotypic coefficient of variation (CV) for type traits ranged from 0.23 to 0.32 (ARP) and from 0.22 to 0.35 (ABP-CN; data not shown). Similar values of phenotypic CV were calculated using data from Holstein-Friesian (from 0.20 to 0.30; Brotherstone et al., 1990) and Guernsey dairy cattle (from 0.22 to 0.34; Cruickshank et al., 2002). A wider range (0.18 to 0.49) of phenotypic CV was reported in Italian Jersey cows (Biscarini et al., 2003).

Results from the ANOVA are summarised in Table 2. Due to a high computational demand, the fixed effect of HYC was not directly analysed but treated with the ABSORB statement of GLM procedure (SAS, 2009) and retained within the model. Preliminary analysis on small samples revealed an high statistical significance of this effect for all traits, in agreement with findings of Theron and Mostert (2004), who reported a strong influence of HYC on type traits of Jersey and Holstein breeds. The fixed effects of DIM and age at calving (AGE) were important to explain the variation of almost all traits of ARP, with the exception of rear legs for DIM (P>0.05) and of thinness and teat placement side view for AGE (P>0.05). Gengler et al. (1997) and Nouman and Abrar (2013) reported a significant effect of these factors on linear type traits of Jersey and Sahiwall cows, respectively. Regarding ABP-CN, neither DIM nor AGE were significant effects for thinness, rear legs, foot angle and teat placement rear view (P>0.05). Furthermore, DIM was not significant for rump angle, and AGE was not significant for udder width and suspensory ligament (P>0.05).

Although least square means for the individual body size traits increased with stage of lactation, the increase was only different from zero (P<0.001) for stature (ARP) and thorax depth (ABP-CN). All individual fleshiness traits increased (P<0.01) with DIM, and front muscularity, back, loins and rump, and thigh, buttock side view in ABP-CN strain showed a more significant increase (P<0.001). In contrast, rear and fore udder attach, udder width and teat placement side view decreased (P<0.001) with stage of lactation in ABP-CN cows, whereas for teat length and for rump width little less significant variations were found (P<0.01). The individual udder traits for ARP showed decreases for udder width (P<0.01) and for rear and fore udder attach and teat placement side view (P<0.05) with DIM. For these type traits the decrease was more marked after 180 d of lactation. An increase (P<0.01) for rump angle and width with DIM was also found.

No significant variations of type traits across classes of age were found, except for stature, thorax depth and width, front muscularity and rump width of first-parity ARP cows (P<0.01). Least squares means of several type traits increased with age at first calving of Holstein cows (Cassel et al., 1973; Lawstuen et al., 1987). An increase across age was found for udder depth and foot angle (P<0.05) during second lactation. The absence of clear trends of least squares means across age in second lactation cows may indicate that animals show less morphological variation than first-parity cows, being more mature then cows at their first calving.

Table 2. Results from ANOVA for type traits of Aosta Red Pied (ARP) and Aosta Black Pied and Chestnut (ABP-CN) cows

Trait	ARP		ABP-CN	
	DIM[1]	AGE[2]	DIM[1]	AGE[2]
Composite				
Body size	20.11***	94.56***	6.55***	48.59***
Fleshiness	18.08***	57.93***	6.00***	63.13***
Body shape	4.03***	11.17***	3.43**	13.90***
Udder	44.95***	6.06***	22.00***	2.08***
Individual				
Stature	14.90***	67.19***	7.02***	32.65***
Body length	20.30***	77.57***	9.09***	39.23***
Thorax depth	13.08***	77.75***	6.09***	45.7***
Thorax width	17.28***	79.66***	7.01***	53.18***
Front muscularity	13.63***	50.88***	5.12***	44.78***
Back, Loins and Rump	16.83***	38.79***	2.66*	39.26***
Thigh, Buttock side view	12.15***	60.09***	4.39***	54.95***
Thigh, Buttock rear view	12.98***	54.65***	6.64***	53.75***
Thinness	2.37*	1.45	2.00	1.10
Rump angle	2.39*	2.68**	0.73	2.13*
Rump width	18.99***	96.06***	5.10***	35.92***
Rump length	19.73***	60.02***	4.51***	19.43***
Rear legs	1.14	2.91**	0.85	0.83
Foot angle	2.42*	2.19*	0.72	1.30
Fore udder attach	55.82***	11.08***	27.80***	4.12***
Rear udder attach	53.85***	7.32***	12.54***	2.14*
Udder width	67.58***	6.68***	14.22***	1.68
Udder depth	8.20***	15.38***	7.14***	5.09***
Suspensory ligament	8.07***	3.71***	3.55**	1.47
Teat placement rear view	2.50*	2.77**	1.91	1.46
Teat placement side view	23.96***	1.14	10.76***	3.92***
Teat length	2.62*	8.7***	2.36*	2.31*

[1] DIM – fixed effect of days in milk; [2] AGE – fixed effect of age at calving.

Conclusions

This study showed the strong influence of herd-year-classifier on type traits. Days in milk and age at calving significantly influenced most of the type traits, with only few exceptions. This work is a good starting point to set up a genetic model aimed at estimating genetic parameters for type traits of Valdostana cattle.

References

Albera A., Mantovani R., Bittante G., Groen A. F., Carnier P. (2001). Genetic parameters for daily live-weight gain, live fleshiness and bone thinness in station-tested Piemontese young bulls. Anim Sci 72: 449-456

Berry D.P., Buckley F., Dillon P., Evans R.D., Veerkamp R.F. (2004). Genetic relationship among linear type traits, milk yield, body weight, fertility and somatic cell count in primiparous dairy cows. Irish J Agr Food Res 43: 161-176

Biscarini F., Biffani S., Canavesi F. (2003). Genetic analysis of type traits for the Italian Jersey breed. In: Proceedings of the 2003 Interbull meeting, No. 31. Rome, Italy

Brotherstone S., McManus C. M., Hill W. G. (1990). Estimation of genetic parameters for linea and miscellaneous type traits in Holstein-Friesian dairy cattle. Livest Prod Sci 26: 177-192

Cassel B. G., Vinson W. E., White J. M., Kliewer R. H. (1973). Age correction factors for type traits in Holstein cows. J Dairy Sci 56: 1178-1180

Cruickshank J., Weigel K. A., Dentine M. R., Kirkpatrick B. W. (2002). Indirect prediction of herd life in Guernsey dairy cattle. J Dairy Sci 85: 1307-1313

Forabosco F., Rossetti E., Sarti F. M., Panella F., Bittante G., Mantovani R., Filippini F. (2005). In: 4th World Italian Beef Cattle Congress, Gubbio, Italy 163-166

Foster W. W., Freeman A. E., Berger P. J. (1989). Association of type traits scored linearly with production and herdlife of Holsteins. J Dairy Sci 72: 2651-2664

Gengler N., Wiggans G. R., Wright J. R., Norman H. D., Wolfe C. W. (1997). Estimation of (co)variance components for Jersey type traits using a repeatability model. J Dairy Sci 80: 1801-1806

Lawstuen D. A., Hansen L. B., Johnson L. P. (1987). Inheritance and relationship of linear type traits for age groups of Holsteins. J Dairy Sci 70: 1027-1035

Mantovani R., Gallo L., Carnier P., Cassandro M., Bittante G. (1997). The use of a juvenile selection scheme for genetic improvement of small population: the example of Rendena breed. In: 48th Annual Meeting of the European Association of Animal Production, Vienna, Austria (unpublished)

Mantovani R., Cassandro M., Contiero B., Albera A., Bittante G. (2010). Genetic evaluation of type traits in hypertrophic Piemontese cows. J Anim Sci 88: 3504-3512

Meyer K., Brotherstone S., Hill W. G. (1987). Inheritance of linera type traits in dairy cattle and correlations with milk production. Anim Prod 44: 1-10

Misztal I., Lawlor T. J., Short T. H., VanRaden P. M. (1992). Multiple-trait estimation of variance components of yield and type traits using an animal model. J Dairy Sci 75: 544- 551

Němcová E., Štípková M., Zavadilová L. (2011). Genetic parameters for linear type traits in Czech Holstein cattle. Czech J Anim Sci 56(4): 157-162

Nouman S., Abrar Y. (2013). Multiple and stepwise regression of reproduction efficiency on linear type traits in Sahiwall cows. Int J Livest Prod 4(1): 14-17

Samoré A. B., Rizzi R., Rossoni A., Bagnato A. (2010). Genetic parameters for functional longevity, type traits, somatic cell scores, milk flow and production in the Italian Brown Swiss. Ital J Anim Sci 9: e28

Sartori C., Mantovani R. (2010). Genetics of fighting ability in cattle using data from the traditional battle contest of the Valdostana breed. J Anim Sci 88: 3206-3213

SAS Institute Inc. (2009). SAS/STAT ® 9.2 User's Guide, Second Edition. Cary, NC: SAS Institute Inc.

Theron H. E., Mostert B. E. (2004). Genetic analyses for conformation traits in South African Jersey and Holstein cattle. S Afr J Anim Sci 34: 47-49

Vukasinovic N., Moll J., Künzi N. (1997). Factor analysis for evaluating relationship between herd life and type traits in Swiss Brown cattle. Livest Prod Sci 49: 227-234

Wall E., White I. M. S., Coffey M. P., Brotherstone S. (2005). The relationship between fertility, rump angle, and selected type information in Holstein-Friesian cows. J Dairy Sci 88: 1521-1528

Wiggans G. R., Thornton L. L. M., Neitzel R. R., Gengler N. (2006). Genetic parameters and evaluation of rear legs (rear view) for Brown Swiss and Guernseys. J Dairy Sci 89: 4895-4900

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