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Original study

Genetic analysis of values, trends and relations between conformation and milk traits in Polish Holstein-Friesian cows

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Abstract

In the work presented, an analysis of the genetic values of conformation traits and their relations with the genetic value of dairy traits based on dairy performance (milk, fat and protein yield) and conformation data, was performed. Data were obtained for Polish Holstein-Friesian cows of the Black-and-White variety, maintained in 21 herds in the region of Wielkopolska (central Poland) and born between 2001 and 2004. The genetic values for the data analysed were estimated using the BLUP (best linear unbiased prediction) method and a mixed model. For the traits analysed, a genetic trend as well as genetic correlations between the dairy and conformation traits were estimated. The population analysed was divided depending on the year of birth and production level. The results obtained show a systematic increase in the traits analysed (positive genetic trends) both for dairy and conformation traits (with the exception of temperament). The highest genetic correlations between dairy and conformation traits were obtained for the udder, temperament and dairy type, while the lowest were obtained for height at sacrum and calibre. The analysis of the genetic value of conformation traits in cows of different dairy production genetic values indicated that the highest results were obtained for the group of animals with the highest genetic dairy production value. In turn, the analysis of the genetic value of traits of cows born in different years did not show statistically significant differences, with the exception of height in the youngest group.

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Abbreviations: BLUP: best linear unbiased prediction

Introduction

Evaluation of cattle conformation is an important element of breeding work conducted on this species and in many countries it is included in the selection index (Cue *et al.* 1996). The evaluation methods vary with regard to the method as well as the number of traits recorded. Conformation traits have been taken into consideration as result of phenotypic and genetic correlations observed between conformation and dairy performance traits (Visscher & Goddard 1995, Vukašinović *et al.* 1995, Püski *et al.* 2001, Karwacki & Sobek 2002, Pérez-Cabal & Alenda 2002, Kruszyński *et al.* 2006, Guliński *et al.* 2005, Kruszyński *et al.* 2007), the quality of the product obtained, the somatic cell count in milk (Mrode *et al.* 2000, Gulyas & Iväncsics 2001, Amin *et al.* 2002, Orban *et al.* 2011), reproduction traits (Pryce *et al.* 2002, Jagusiak 2006) and functional traits (health, length of productive life and survival) (Rogers *et al.* 1989, Vukašinović *et al.* 1995, Haile-Mariam *et al.* 2003, Neuenschwander *et al.* 2005, Sewalem *et al.* 2005, Pérez-Cabal *et al.* 2006, Strapák *et al.* 2010). The evaluation of conformation traits is of similar importance in the breeding work conducted on other species like sheep (Serrano *et al.* 2002, Schulz *et al.* 2004, Marie-Etancelin *et al.* 2005, Kukovics *et al.* 2006) and goats (Pawlina *et al.* 2005).

In the study presented here, an analysis of the genetic value of conformation traits in cows and their relation with the genetic value of dairy traits was performed.

Material and methods

Material

The studies were conducted on the data recorded for dairy production traits and results of a conformation evaluation obtained for 1928 first lactation Polish Holstein-Friesian Black-and-White variety cows, born between 2001 and 2004 and maintained in the Wielkopolska region (central Poland).

Methods

The production traits analysed included the yield of milk, milk fat and milk protein obtained during a physiologically finished first lactation not shorter than 240 days. The conformation traits that were examined included height, calibre, depth of trunk, dairy type, temperament, milking speed, locomotion, width of rump, rump angle, udder placement, width of udder, for and rear udder attachment, udder median ligament, teat placement, teat length, legs side view, legs rear view and hooves (evaluated at a 1-9 score between the 30th and 300th day after calving). The grades within particular traits depended on the morphological appearance of particular elements (Table 1).

Table 1
Tested conformation traits of cows and their scores

Trait	Points				
	9	7	5	3	1
Height – height at withers	very tall (above 145 cm)	tall (141-145 cm)	medium (136-140 cm)	short (131-135 cm)	very short (below 130 cm)
Caliber	exceptionally wide and strong fore-part	wide and strong fore-part	medium	narrow fore-part	exceptionally narrow
Trunk depth	exceptionally deep fore-part	deep fore-part	medium	shallow	exceptionally shallow
Dairy type	very gentle, built on a isosceles triangular plan	above the average	average	below the average	undesirable–coarse
Temperament	perfect	above the average	average	troublesome	especially troublesome
Milking speed	exceptionally quick	quick	average	slow	especially slow
Locomotion	perfect locomotion	above the average	average	walks with some difficulties	special difficulties at walking
Rump width at ischial tuberosities	very wide (above 16.5 cm)	wide (14.5-16.5 cm)	average (12-14 cm)	narrow (10-11.5 cm)	very narrow (below 10 cm)
Rump angle, placement of ischial tuberosities with respect to iliac ones	very slanting (above 10 cm)	moderate slant (6-10 cm)	small slant (1-5 cm)	streight (0 cm)	rebuilt (hips above iliac tuberosities)
Udder placement-distance from crurotalar joint to teats base	very shallow (above 10 cm)	high above the crurotalar joint (5-10 cm)	slightly above the joint (1-5 cm)	equally with the crurotalar joint (0 cm)	very deep, saggy (below the crurotalar joint)
Udder width	very wide (above 17 cm)	wide (16.5-17 cm)	average (14-16 cm)	narrow (11.5-13.5 cm)	very narrow (below 11.5 cm)
Fore udder attachment	very strong and tight	strong	moderately strong	very loose	exceptionally loose
Rear udder attachment as a distance from vulva to udder base	very tall (below 22 cm)	tall (26-22.5 cm)	average (30-26.5 cm)	low (34-30.5 cm)	very low (above 34 cm)
Median ligament	very strong (above 5 cm)	distinctly marked division (5 cm)	distinct division (2-4.5 cm)	flat udder base (1 cm)	lack of division)
Teats placement	very convergent	convergent	placed centrically	divergent	very divergent
Teats length	very long (above 7 cm)	long (6.5-7 cm)	average (5.5-6 cm)	short (4.5-5 cm)	very short (below 4.5 cm)
Legs side view	exceptionally sickled; sabre-shaped in crurotalar joint	average angling of the crurotalar joint	slight angling	straight crurotalar joint	exceptionally column-shaped
Legs rear view	straight	slightly toe-out	moderately toe-out	distinctly toe-out	hooves sharply out
Hooves placement angle	exceptionally sharp angle	sharp angle (45°)	average (40°)	flat (35°)	exceptionally flat

Moreover, the results obtained for certain traits were analysed within the following groups: udder traits (placement, for and rear attachment, width, median ligament, teat length and placement – evaluated at a 1-63 score), body traits (height, calibre, depth of chest, depth and rump angle – evaluated at a 1-45 score) and leg traits (legs side and rear view and hooves – evaluated at a 1-27 score).

Statistical methods

The genetic values for the traits analysed were estimated using the DFREML package (Meyer 1989, Meyer 1998) and the BLUP method applying the following mixed model:

$$\boldsymbol{y} = \boldsymbol{X\beta} + \boldsymbol{Za} + \boldsymbol{e}$$

$$\text{assuming that: } E\begin{bmatrix} a \\ e \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \quad var = \begin{bmatrix} a \\ e \end{bmatrix} = \begin{bmatrix} \sigma_a^2 A & 0 \\ 0 & \sigma_a^2 I \end{bmatrix} \qquad (1)$$

where $\boldsymbol{y}$, $\boldsymbol{\beta}$, $\boldsymbol{a}$ and e stand for observation vectors, fixed model effects (herd – 1, …, 21; year – 1,…, 4; season – 1,…, 6), additive animal effects and residual variances, respectively, while $\boldsymbol{X}$ and $\boldsymbol{Z}$ stand for the matrix for fixed effects and for animal additive effects, respectively. It is also assumed that σ_a^2 and σ_e^2 stand for the genetic additive and residual variations, while $\boldsymbol{A}$ and I stand for the additive relationship and identity matrix. Genetic correlations have been calculated between the estimated genetic values of production and conformation traits.

The mean annual genetical trend for the dairy production traits analysed was estimated using the method of linear regression as a coefficient of the regression of the mean breeding value of animals born in a given year against time.

Due to the considerable evaluation score (at least 1 to 9 points for the conformation linear traits) the data transformation was not performed as the distribution obtained was normal or close to normal, what made statistical analyses possible (using linear models) without the necessity of normalisation of the data distribution.

The statistical analyses (means, standard deviations for the traits analysed, testing skewness of distribution for conformation values and estimation of genetic trends) for all data collected were performed using the procedures proc MEANS, proc UNIVARIATE and proc REG as well as the linear model GLM from the statistical package SAS 9.1 (SAS Institute Inc., Cary, NC, USA), while the significance of differences was tested by Duncan's test.

The population studied was analysed according to the genetic value for milk yield, with three levels being differentiated: bellow 6800 kg (n=485), between 6801 and 7150 kg (n=946) and over 7151 kg (n=534). Moreover, four groups of animals were separated on the basis of a second criterion, i.e. year of birth of the primiparous cow: animals born in 2001 (116 heads), in 2002 (933 heads), in 2003 (753 heads) and in 2004 (125 heads).

Results

The data presented in Table 2 characterise the population examined with regard to the genetic value of dairy production and conformation traits. The genetic values for conformation traits differed considerably. The highest values (exceeding 6 points) were obtained for the dairy type, legs rear view, locomotion and udder placement, while the lowest (bellow 5 points) were obtained for traits describing teats (length and placement) and for temperament. The genetic values for the remaining conformation traits analysed ranged from 5 to 6 points.

The mean annual genetic trends calculated for the population examined were positive for a majority of traits. The mean genetic value for the yield of milk, fat and protein increased over the period analysed (by: 10.38 kg; 0.51 kg and 0.23 kg per year, respectively). In turn, the content of fat and protein in milk decreased (negative trend: −0.002 and −0.004 per cent per year, respectively). The trends estimated for conformity traits were also mostly positive (with the exception of temperament, for which the trend recorded decreased annually by 0.045 points). The highest increase was recorded for the trunk traits treated jointly (by 0.20 points per year). This included an annual increase of 0.106 points for height, 0.052 points for calibre and 0.035 points for chest depth. Among traits characterizing the udder the highest value was obtained for rear udder attachment (0.012 points). For the remaining traits the mean annual values for the genetic trend proved to be very small.

Table 2
Genetic values and genetic trend for dairy and conformation traits

Trait	Points	$\bar{x}$	SD	Min	Max	Genetic trend
Milk yield, kg		7004	256.4	5961.1	7763.6	10.38
Milk fat yield, kg		279.5	9.7	242.9	312.7	0.51
Milk protein yield, kg		231.9	8.2	197.6	255.8	0.23
Milk fat content, %		4.04	0.09	3.54	4.46	−0.002
Milk protein content, %		3.33	0.04	2.90	3.51	−0.004
Height	1-9	6.05	0.84	2.37	8.74	0.106
Calibre	1-9	5.99	0.42	4.01	7.34	0.052
Trunk depth	1-9	6.06	0.37	4.41	7.48	0.035
Dairy type	1-9	6.33	0.02	6.23	6.38	0.003
Temperament	1-9	4.89	0.64	2.04	7.03	−0.045
Milking speed	1-9	5.13	0.23	3.14	6.26	0.009
Locomotion	1-9	6.22	0.01	6.22	6.23	0.008
Rump width	1-9	5.90	0.27	4.90	6.83	0.001
Rump angle	1-9	5.41	0.13	4.92	5.89	0.011
Udder placement	1-9	6.21	0.18	5.28	6.75	0.007
Udder width	1-9	5.71	0.06	5.49	5.87	0.002
Fore udder attachment	1-9	6.00	0.11	5.53	6.27	0.001
Rear udder attachment	1-9	5.39	0.21	4.54	6.18	0.012
Median ligament	1-9	5.66	0.11	5.21	5.99	0.008
Teat placement	1-9	4.73	0.04	4.55	4.88	0.002
Teat length	1-9	4.14	0.17	3.66	4.93	0.001
Legs side view	1-9	5.37	0.21	4.40	6.27	0.002
Legs rear view	1-9	6.42	0.09	6.10	6.80	0.004
Hooves	1-9	6.07	0.01	6.07	6.08	0.001
Udder traits	1-63	37.82	0.76	33.52	40.31	0.039
Trunk traits	1-45	35.66	2.02	26.78	42.73	0.200
Leg traits	1-27	17.90	0.32	16.45	19.18	0.015

The genetic correlations obtained between dairy production and conformation traits (Table 3) show that the highest values for this indicator were observed between milk yield (r_G=0.09), fat yield (r_G=0.14) and protein yield (r_G=0.09). For traits characterising the udder, the highest value was recorded between the dairy production traits analysed and the width of udder, teat placement and rear udder attachment. Among the remaining conformation traits analysed positive correlations were observed between the dairy type and yield of milk and milk protein (r_G=0.11) and between temperament and yield of milk (r_G=0.07), fat (r_G=0.08) and protein (r_G=0.09). In the studies presented, the trunk traits treated jointly showed comparatively low correlations with production traits (from r_G=0.04 for fat yield to r_G=0.07 for milk and milk protein yield). Within this group of traits positive and higher correlations were observed between the height and the yield of milk and milk protein (r_G=0.05 and r_G=0.04, respectively) and between calibre and milk yield (r_G=0.05).

Table 3
Genetic correlations between conformation and dairy traits

Trait	Milk yield	Milk fat yield	Milk protein yield	Milk fat content	Milk protein content
Height	0.05	0.01	0.04	−0.08	−0.05
Calibre	0.04	−0.01	0.02	−0.08	−0.08
Trunk depth	0.01	−0.02	−0.01	−0.05	−0.06
Dairy type	0.11	0.02	0.11	−0.14	−0.07
Temperament	0.07	0.08	0.09	0.01	0.04
Milking speed	−0.08	−0.03	−0.07	0.11	0.05
Locomotion	−0.08	−0.02	−0.10	0.011	−0.03
Rump width	−0.01	0.03	0.03	0.07	0.10
Rump angle	−0.02	0.04	0.03	0.11	0.16
Udder placement	0.10	−0.03	−0.08	0.08	0.04
Udder width	0.30	0.25	0.30	−0.06	−0.03
Fore udder attachment	−0.04	0.01	−0.03	−0.09	0.03
Rear udder attachment	0.09	0.11	0.08	0.05	−0.05
Median ligament	−0.01	−0.01	−0.04	0.01	−0.10
Teat placement	0.13	0.26	0.19	0.19	0.20
Teat length	−0.04	0.01	−0.05	0.07	0.001
Legs side view	0.02	0.06	0.002	0.05	−0.04
Legs rear view	−0.09	0.05	−0.03	0.21	0.18
Hooves	0.01	−0.01	0.02	−0.04	−0.01
Udder traits	0.09	0.14	0.09	0.09	−0.006
Trunk traits	0.07	0.04	0.07	−0.05	−0.04
Leg traits	−0.02	0.04	−0.006	0.09	0.05

The content of fat and protein in milk was most strongly and positively related to teat placement (r_G=0.19 and r_G=0.20, respectively). A comparatively high correlation value was obtained for the content of fat and protein in milk and the legs rear view, as well as traits characterising the rump. In the case of the remaining conformation traits analysed the correlation with the content of fat and protein in milk was close to zero, whether negative or positive.

The analysis of the genetic value of conformation traits for cows characterised by different genetic values of milk production (Table 4) indicates that in case of a majority of the conformation traits examined, animals belonging to the group with the highest milk yield showed also the highest genetic values of conformation traits. The highest and statistically significant ($P \leq 0.01$) differences for udder traits were recorded between the group with the highest dairy productivity (37.93 points) and the remaining groups. Among traits describing the udder a tendency to increase the score depending on milk yield was observed for the width of udder, rear attachment and teat placement. Only in the case of teat length no statistically significant differences were observed between the groups examined. Also for the trunk traits higher values (at $P \leq 0.05$) were observed in groups with a higher milk yield: from 35.56 points in the group with the lowest yield, through 35.61 points in group two, to 35.82 points in the group with the highest yield. In turn, an analysis of individual traits describing the trunk indicates that a similar tendency was observed only in relation to height, while the remaining trunk traits did not show similar tendencies. A slightly smaller score for the group with the highest milk yield compared with that with the lowest yield was observed for depth of trunk, rump width and angle. For the leg traits, the lowest genetic value was obtained for group two (17.87 points) and the difference proved statistical significance ($P \leq 0.01$) in relation to group one (17.93 points) and three (17.92 points). A similar situation with higher values obtained for group one and three than for group two was observed for genetic values characterising legs' side and rear view. Of the remaining traits analysed it is worth drawing attention to the temperament, for which the highest genetic value was obtained for group three (significant at $P \leq 0.01$).

An analysis of the differentiation of conformation traits in cows depending on year of birth (2001-2004) showed very small differences between the groups analysed (Table 5). Statistically significant differences occurred only between the genetic values obtained for height (at $P \leq 0.05$) where the lowest value (5.93 points) was observed for the group born in 2001, while the highest (6.27 points) was found in the group born in 2004.

Table 4
Genetic value of the conformation traits in cows (scores) depending on the level of milk yield

Trait	Level 1, n=485		Level 2, n=909		Level 3, n=534	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Height	6.02^{AB}	0.84	6.00^{A}	0.85	6.15^{B}	0.84
Calibre	5.99	0.39	5.98	0.40	6.01	0.41
Trunk depth	6.07	0.36	6.07	0.37	6.04	0.38
Dairy type	6.31^{A}	0.03	6.33^{AB}	0.02	6.33^{B}	0.02
Temperament	4.84^{A}	0.66	4.87^{A}	0.59	4.99^{B}	0.70
Milking speed	5.17^{A}	0.66	5.13^{AB}	0.22	5.12^{B}	0.24
Locomotion	6.21^{A}	0.01	6.22^{AB}	0.01	6.23^{B}	0.01
Rump width	5.91	0.29	5.89	0.27	5.90	0.26
Rump angle	5.42	0.13	5.41	0.13	5.41	0.13
Udder placement	6.24^{A}	0.18	6.20^{B}	0.19	6.20^{B}	0.17
Udder width	5.69^{A}	0.05	5.71^{B}	0.05	5.73^{C}	0.05
Fore udder attachment	6.02^{a}	0.09	6.01^{ab}	0.10	6.00^{b}	0.10
Rear udder attachment	5.36^{A}	0.21	5.39^{AB}	0.21	5.42^{B}	0.23
Median ligament	5.67^{a}	0.12	5.65^{b}	0.10	5.66^{b}	0.11
Teat placement	4.73^{A}	0.04	4.73^{A}	0.04	4.75^{B}	0.04
Teat length	4.15	0.20	4.14	0.16	4.13	0.16
Legs side view	5.37	0.24	5.36	0.22	5.38	0.19
Legs rear view	6.43^{Aa}	0.11	6.40^{B}	0.08	6.42^{Ab}	0.08
Hooves	6.07	0.01	6.07	0.01	6.07	0.01
Udder traits	37.75^{A}	0.71	37.80^{A}	0.76	37.93^{B}	0.80
Trunk traits	35.56^{a}	1.93	35.61^{ab}	2.02	35.82^{b}	2.10
Leg traits	17.93^{A}	0.38	17.87^{B}	0.29	17.92^{A}	0.28

^{ABab}Means with different letters differ significantly, capital letters $P \leq 0.01$, small letters – $P \leq 0.05$

The same was observed for hooves where the lowest value (6.06 points) was seen for cows born in 2002, while the highest (6.08 points) could be shown for cows born in 2003. The remaining traits (principally characterising the udder and legs), whether analysed jointly or separately for each trait, remained on a very similar level in most cases. The joint evaluation of the trunk constituted the only exception, as it showed a clear tendency to increase over the subsequent years of birth. A similar situation was observed for traits describing the trunk – height and calibre. A somewhat less clear increase was observed for milking speed with values from 5.09 (cows born in 2001) to 5.13 points (cows born in 2004). In turn, a systematic decrease was observed for temperament (from 4.95 points for cows born in 2001 to 4.79 points for cows born in 2004).

Table 5
Genetic values for conformation traits in cows (scores) born in the years 2001-2004

Trait	2001, n=116		2002, n=933		2003, n=733		2004, n=125	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Height	5.93[a]	1.00	6.04[ab]	0.85	6.08[ab]	0.80	6.27[b]	0.57
Calibre	5.92	0.59	5.99	0.39	6.00	0.38	6.09	0.37
Trunk depth	6.01	0.45	6.05	0.36	6.07	0.36	6.12	0.36
Dairy type	6.32	0.03	6.32	0.02	6.33	0.02	6.33	0.01
Temperament	4.95	0.75	4.88	0.67	4.91	0.59	4.79	0.13
Milking speed	5.09	0.31	5.15	0.26	5.12	0.16	5.13	0.17
Locomotion	6.22	0.01	6.23	0.01	6.23	0.01	6.23	0.01
Rump width	5.86	0.29	5.90	0.27	5.91	0.27	5.86	0.22
Rump angle	5.43	0.13	5.41	0.13	5.40	0.12	5.44	0.14
Udder placement	6.18	0.24	6.20	0.18	6.21	0.16	6.20	0.10
Udder width	5.71	0.06	5.71	0.06	5.71	0.05	5.72	0.04
Fore udder attachment	6.01	0.10	6.00	0.10	6.00	0.10	6.01	0.07
Rear udder attachment	5.38	0.23	5.39	0.22	5.39	0.21	5.42	0.14
Median ligament	5.65	0.11	5.65	0.11	5.67	0.11	5.67	0.06
Teat placement	4.73	0.05	4.74	0.06	4.73	0.04	4.74	0.04
Teat length	4.16	0.17	4.15	0.18	4.13	0.16	4.17	0.10
Legs side view	5.36	0.26	5.36	0.33	5.38	0.18	5.36	0.30
Legs rear view	6.39	0.10	6.41	0.10	6.42	0.07	6.40	0.01
Hooves	6.07[ab]	0.01	6.08[a]	0.01	6.07[b]	0.01	6.07[ab]	0.01
Udder traits	37.80	0.91	38.05	0.77	37.84	0.73	38.00	0.45
Trunk traits	35.36	2.51	35.65	2.00	35.70	1.97	36.01	1.28
Leg traits	17.86	0.35	17.89	0.34	17.92	0.27	17.90	0.15

[ab]Means with different letters differ significantly at $P \leq 0.05$

Discussion

In the population analysed the genetic values for conformation traits were higher (by about 0.3 point) for all traits characterising the udder (with the exception of teat length – score lower by as much as 0.5 point), lower for the angle and width of rump and for dairy type (by about 0.2 point), considerably higher (by about 1 point) for traits characterising hooves and legs and lower (by about 0.3 point) for depth of trunk than those reported by Jagusiak (2006) and Żarnecki *et al.* (2003), which were obtained for a different population of Polish Holstein-Friesian cattle. In turn, in their studies on Swiss Holstein Friesian cattle Neuenschwander *et al.* (2005) also obtained lower (by about 0.2 point) values for the udder conformation parameters examined (with the exception of median ligament and teat length – higher by about 0.5 point) than those reported in the present work. As regards other conformation traits the differences observed were much smaller. The studies reported by Cue *et al.* (1996) conducted on New Zealand Holstein-Friesian cattle present similar genetic values for height and calibre, higher for temperament and lower for a majority of udder traits.

The highest values for genetic correlations calculated in the present investigations were observed between milk yield and traits characterising the udder, of which the width of udder is worth emphasising as it reached r_G=0.30. A somewhat higher value (r_G=0.34) was reported by Guliński *et al.* (2005) for Black-and-White cattle from Eastern Poland and this was the highest correlation value reported in the papers cited. Similar in character though lower (r_G=0.16) was the value for this parameter reported by Short & Lawlor (1992) for Holstein-Friesian cattle. A clearly different result was obtained by Neuenschwander *et al.* (2005) in studies conducted on a population of Holstein-Friesian cattle in Switzerland (r_G=–0.16). In the present studies a relatively high correlation was obtained for teat placement (r_G=0.13) and this was similar to the results reported by Guliński *et al.* (2005). In turn, Vukašinović *et al.* (1995) obtained a clearly higher value (r_G=0.40). Visscher & Goddard (1995) as well as Short & Lawlor (1992) estimated those correlations as low and negative (r_G=–0.04 and r_G=–0.03, respectively). A positive correlation between the udder placement and milk yield was reported by Vukašinović *et al.* (1995; r_G=0.40). Other authors obtained totally different values (Short & Lawlor 1992 – r_G=–0.41 and Guliński *et al.* 2005 – r_G=–0.13). The genetic correlation between milk yield and rear udder attachment was positive and ranged from low values in the present study (r_G=0.09) and those reported by Neuenschwander *et al.* (2005; r_G=0.17) to medium in investigations described by Visscher & Goddard (1995), Guliński *et al.* (2005) and Vukašinović *et al.* (1995) - r_G=0.6, r_G=0.1 and r_G=0.0, respectively. In turn, the fore udder attachment, both in own studies and in those reported by other authors (Neuenschwander *et al.* (2005) – r_G=–0.03, Short & Lawlor (1992) – r_G=–0.23, Guliński *et al.* (2005) and Visscher & Goddard (1995) – r_G=0.08) demonstrated a low correlation with milk yield both negative or positive. Only in the studies conducted by Vukašinović *et al.* (1995) the coefficient of correlation was medium and positive (r_G=0.48). A low and negative correlation for the median ligament, similar to that presented here, was also reported by Neuenschwander *et al.* (2005).

Among the conformation traits not connected with the udder the highest correlation coefficient with milk yield was obtained for dairy type (r_G=0.11). Also a positive but clearly higher correlation was obtained by Short & Lawlor (1992; r_G=0.52) and Visscher & Goddard (1995; r_G=0.50).

Traits describing the trunk showed only small correlations with milk yield. In the present studies (r_G=0.04) as in those conducted by Neuenschwander *et al.* (2005; r_G=0.09), the correlation between calibre and milk yield was not as pronounced as that reported by Visscher & Goddard (1995), who reached a value of r_G=0.24. Similarly diverse results were obtained when analysing the relation between the genetic value for height and milk yield. The correlation coefficients ranged from negative (r_G=–0.15) reported by Guliński *et al.* (2005), through a lack of correlations observed in studies conducted by Short & Lawlor (1992; r_G=0.01) to positive shown by Visscher & Goddard (1995; r_G=0.24). In turn, correlations between trunk depth and milk yield, both in own studies and in those reported by the authors cited, demonstrated very low, similar values from r_G=0.01 in own studies to r_G=−0.07 in studies conducted by Short & Lawlor (1992).

In the present study no positive genetic correlations between milk yield and traits characterising the legs were observed. The works of other authors do show such relations. The highest correlation values (r_G=0.34 – legs side view) were obtained by Guliński *et al.* (2005). For the remaining traits: legs rear view and hooves, the correlations obtained were more differentiated (from negative to positive) and the values were considerably lower (from r_G=−0.14 – Guliński *et al.* 2005 to r_G=0.05 – Visscher & Goddard 1995).

The relations between conformation traits and fat and protein content in milk are relatively poorly described in the literature available. As regards udder traits, which similarly as in the present study were correlated with the fat content, positive correlations were reported by Guliński *et al.* (2005) for the udder placement, udder attachment and median ligament (r_G=0.16; r_G=0.25; r_G=0.20, respectively). In the present work similar values were obtained only for udder placement (r_G=0.08), while for the remaining udder traits the results were different from those reported by the authors cited. Of the traits describing the trunk, high and positive correlations with milk fat content Guliński *et al.* (2005) obtained for depth of trunk (r_G=0.40), height (r_G=0.29), calibre (r_G=0.24) and width of rump (r_G=0.25). In the studies presented here a positive but clearly lower correlation was observed only for the width of rump (r_G=0.07).

In turn, the relation between the genetic values of conformation traits and the content of protein in milk presented by Guliński *et al.* (2005) differed even more than those described for fat content. The highest correlations between protein content in milk and traits characterising the udder were recorded by Guliński *et al.* (2005) for the fore udder attachment (r_G=0.25), mean ligament (r_G=0.25) and teat placement (r_G=0.12). In our investigations also a positive though higher correlation was observed between protein content in milk and teat placement (r_G=0.20), while the correlation with the udder placement was lower (r_G=0.04). Of the traits describing the trunk in the studies cited the highest correlation values were reported for height (r_G=−0.30).

References

Amin AA, Gere T, Kishk WH (2002) Genetic and environmental relationship among udder conformation traits and mastitis incidence in Holstein Friesian into two different environments. Arch Tierz 45, 129-138

Cue RI, Harris BL, Rendel JM (1996) Genetic parameters for traits other than production in purebred and crossbred New Zealand dairy cattle. Livest Prod Sci 45, 123-135

Guliński P, Młynek K, Litwińczuk Z, Dobrogowska E (2005) Heritabilities of genetic and phenotypic correlations between condition score and production and conformation traits in Black-and-White cows. Anim Sci Pap Rep 23, 33-41

Gulyas L, Iváncsics J (2001) [Relationship between the somatic cell count and certain udder-morphologic traits]. Arch Tierz 44, 15-22 [in German]

Haile-Mariam M, Bowman PJ, Goddard ME (2003) Genetic and environmental relationship among calving interval, survival, persistency of milk yield and somatic cell count in dairy cattle. Livest Prod Sci 80, 189-200

Jagusiak W (2006) Fertility measures in Polish Black-and-White cattle. 4. Phenotypic and genetic correlations between fertility measures and type traits. J Anim Feed Sci 15, 555-567

Karwacki M, Sobek Z (2002) [Evaluation of relationships between conformation of Black-and-White primiparas and their milk performance]. Acta Sci Pol Zootechnica 1, 75-88 [in Polish]

Kruszyński W, Pawlina E, Wierzbicki H (2006) [Relations between conformation scores and milk performance in primiparous cows of Black-White and Read-White breeds]. Acta Sci Pol Zootechnica 5, 47-55 [in Polish]

Kruszyński W, Pawlina E, Wierzbicki H (2007) [Genetic parameters of conformation traits in primiparous cows of Black and White and Red and White breeds]. Med Weter 63, 196-200 [in Polish]

Kukovics S, Molnár A, Ábrahám M, Németh T, Komlósi I (2006) Effect of udder traits on the milk yield of sheep. Arch Tierz 49, 165-175

Marie-Etancelin C, Astruc JM, Porte D, Larroque H, Robert-Granié C (2005) Multiple-trait genetic parameters and genetic evaluation of udder-type traits in Lacaune dairy ewes. Livest Prod Sci 97, 211-218

Meyer K (1989) Restricted maximum likelihood to estimate variance components for animal models with several random effects using a derivative-free algorithm. Genet Sel Evol 21, 317-340

Meyer K (1998) DFREML Version 3.0 User Notes. Animal Genetics and Breeding Unit, University of New England, Armidale, Australia

Mrode RA, Swanson GJT, Lindberg CM (2000) Genetic correlations of somatic cell count and conformation traits with herd life in dairy breeds, with an application to national genetic evaluations for herd life in the United Kingdom. Livest Prod Sci 65, 119-130

Neuenschwander T, Kadarmideen HN, Wegmann S, de Haas Y (2005) Genetics of Parity-Dependant Production Increase and its Relationship with Health, Fertility, Longevity, and Conformation in Swiss Holsteins. J Dairy Sci 88, 1540-1551

Orbán M, Gaál KK, Pajor F, Szentléleki A, Póti P, Tözsér J, Gulyás L (2011) Effect of temperament of Jersey and Holstein Friesian cows on milk production traits and somatic cell count. Arch Tierz 54, 594-599

Pawlina E, Kruszyński W, Zieleziński M, Bosek M (2005) [Relations between the goat udder dimensions in the first and second lactation]. Med Weter 61, 204-206 [in Polish]

Pérez-Cabal MA, Alenda R (2002) Genetic Relationships between Lifetime Profit and Type Traits in Spanish Holstein Cows. J Dairy Sci 85, 3480-3491

Pérez-Cabal MA, Garciá C, González-Recio O, Alenda R (2006) Genetic and Phenotypic Relationships Among Locomotion Type Traits, Profit, Production, Longevity, and Fertility in Spanish Dairy Cows. J Dairy Sci 89, 1776-1783

Pryce JE, Coffey MP, Brotherstone SH, Woolliams JA (2002) Genetic Relationships Between Calving Interval and Body Condition Score Conditional on Milk Yield. J Dairy Sci 85, 1590-1595

Püski J, Bozó S, Györkös I, Gáspárdy A, Szücs E (2001) [Comparison of the conformation scoring and the body measurement based on four linear traits of Holstein Friesian cows]. Arch Tierz 44, 33-45 [in German]

Rogers GW, McDaniel BT, Dentine MR, Funk DA (1989) Genetics Correlations Between Survival and Linear Type Traits Measured in First Lactation. J Dairy Sci 72, 523-527

Schulz J, Süß R, Fahr RD (2004) [Udder form traits and criteria of udder health in the East Friesian Milk Sheep]. Arch Tierz 47, Special Issue, 81-89 [in German]

Serrano M, Pérez-Guzmán MD, Montoro V, Jurado JJ (2002) Genetic analysis of udder traits in Manchega ewes. Livest Prod Sci 77, 355-361

Sewalem A, Kistemaker GJ, Van Doormaal BJ (2005) Relationship Between Type Traits and Longevity in Canadian Jerseys and Ayrshires Using a Weibull Proportional Hazards Model. J Dairy Sci 88, 1552-1560

Short TH, Lawlor TJ (1992) Genetic Parameters of Conformation Traits, Milk Yield, and Herd Life in Holsteins. J Dairy Sci 75, 1987-1998

Strapák P, Juhás P, Strapáková E, Halo M (2010) Relation of the length of productive life and the body conformation traits in Slovak Simmental breed. Arch Tierz 53, 393-402

Visscher PM, Goddard ME (1995) Genetics Parameters for Milk Yield, Survival, Workability, and Type Traits for Australian Dairy Cattle. J Dairy Sci 78, 205-220

Vukašinović N, Moll J, Künzi N (1995) Genetic relationships among longevity, milk production, and type traits in Swiss Brown cattle. Livest Prod Sci 41, 11-18

Żarnecki A, Morek-Kopeć M, Jagusiak W (2003) Genetic parameters of linearly scored conformation traits of Polish Black-and-White cows. J Anim Feed Sci 12, 689-696