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INFLUENCE OF LEGS AND UDDER EVALUATION ON LONGEVITY AND SELECTED MILK PRODUCTION PARAMETERS IN CZECH FLECKVIEH AND MONTBELIARDE CATTLE

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Abstract

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The aim of this study was to evaluate the influence of udder and legs formation on longevity traits (average lactation at culling, lifelong production) and milk production (maximum amount of milk per lactation, fat content in % and kg, protein content in % and kg) in Czech Fleckvieh, Montbeliarde and their crossbreds. Total 2725 culled Czech Fleckvieh, Montbeliarde cows, and their crossbreeds from two farms were put into dataset. Statistical analysis was performed by SAS 9.3 program. The model equation contained effect of breed, housing, legs formation, and udder formation. The groups for legs (<74.61 points, 74.61–81.90 points, >81.90 points) and udder (<76.94 points, 76.94–81.75 points, >81.75 points) formation were created according arithmetic means and standard deviation. The best results for longevity were in legs formation parameters achieved in group <74.61 points. On the other hand, the best results for milk yield parameters were in legs formation achieved in group >81.90 points. In evaluation udder formation groups were the best and significant ($P < 0.05–0.01$) results for longevity and milk production achieved in group >81.75 points. Only parameters fat and protein percentages were better in group <76.94 points according udder formation. Generally, we can conclude that udder formation was more important than legs formation. From the results we can also conclude that cows with correct exterior do achieve higher longevity and milk production. This confirmed the importance of choosing cows for breeding purposes not only with high potential for milk production, but also for correct exterior parameters and formation.

Keywords: legs, udder, lifelong production, milk components, average lactation at culling

INTRODUCTION

In recent years, the dual purpose cattle breeding are focused on milk and meat production, as well as on exterior, longevity and health parameters. All these traits are connected with stock breeding and they are expression of optimal breeding practice (Dákay *et al.*, 2006). The length of production life according Tsuruta *et al.* (2005) is the feature with low heritability. Decreasing length of production life is primarily connected with high milk yield of cows (Swalve, 2012). Also high fat and protein content in milk is in negative correlation to length of cow's production life (Kučera *et al.*, 2010). The average length of production life is between 2.5 and 3 lactation (Kvapilík *et al.*, 2016); therefore the cows are usually culled just before achieving their maximal milk production. Misztal *et al.*

(1992) found strong relationship between cows' exterior and length of their production life. Longevity is primarily influenced by udder and legs characteristics (Fürst-Waltl, 2004).

The evaluation of udder (10 characteristics) and legs (4 characteristics) in the Czech Republic is described in Breeding program for Czech Fleckvieh breed (Hřeben *et al.*, 2014). Udder formation, including teats, has a positive influence on milk production and length of cow's production life. Highly fixed udder and teats placed in the middle of quarters are an advantage for ensuring the health of mammary gland (Ondráková, 2013). Udder depth is the most important trait influencing cow's longevity (Strapák *et al.*, 2010; du Toit *et al.*, 2012). Bucek and Ondráková (2011) found positive relationship between udder depth and somatic cell count in milk. According to Prichard *et al.* (2013) the low somatic cell count is in positive correlation to length of production life.

Sewalem *et al.* (2005) observed relationships between legs formation and longevity in their study performed on Jersey and Ayrshire cows. According to these authors, cows with extremely formed legs were culled earlier from the herd. Caraviello *et al.* (2004) came to the similar results with Holstein cattle. Also Pérez-Cabal (2006) observed the highest milk production and longevity on cows with the highest legs score. Fűrst (2008), and Kučera *et al.* (2010) added that greater angle and height of feet are important factors influencing fertility, milk yield and the longevity. Ondráková (2013) described, that steeper angulation means the better posture.

The aim of this work was to evaluate the influence of udder and legs formation on longevity traits and milk production in Czech Fleckvieh, Montbeliarde cattle and their crossbreds.

MATERIAL AND METHODS

Data collection

The trial was performed on two farms, where the total number of 2725 culled Czech Fleckvieh (C), Montbeliarde (I) cows, and their crossbreeds (X) (50–88% blood share of C or I) were monitored. The both farms were located at Pardubice region, at 30 km distance from each other and in similar altitude and climatic condition (240 to 260 m. a. s.). In the both farms, cows were housed in reconstructed barns in free cubicle housing technology with rubber mattresses and separate used as bedding. Cows were milked twice a day. In the first farm, milking was carried out in herringbone (fishbone) parlour 2 x 12 stall with fast output. In the second farm, milking was carried out in fast output parlour with 2 x 14 stalls. The drinking water was provided by high volume watering troughs. All the animals were fed by a total mixed ration (TMR). During calving interval, the TMR composition differed especially in quantity of concentrated feed, which corresponded with the phase of lactation and cow's reproduction cycle. The feed was administered twice a day (7:00 AM, 18:00 PM) and gathered up eight times a day.

The exterior evaluation was carried out by the methodology for linear description of Czech Fleckvieh cows (Hřeben *et al.*, 2014). The linear evaluation of exterior was performed from 30 to 210 days after calving in primiparous cows. Four complex characteristic for exterior were described within the system for linear description of Simental, dual purpose breed: body frame, muscularity, legs and udder. Detail description of legs and udder characteristics is presented in further text:

- Legs evaluation contained overall information about: conformation, position, angulation, and total mechanics of movement (hind legs set, heel joint expression, fetlock, foot).
- Udder evaluation contained overall information about: fore udder, rear udder, rear udder attachment, suspensory ligament, udder depth, teats length, teats thickness, teats arrangement, and teats placement.

The data for milk production (milk yield, fat kg, fat%, protein kg, and protein%), linear evaluation (legs, and udder) of exterior and longevity (average lactation at culling, average lifelong production, and maximum amount of milk per lactation) were obtained from dataset of program TPK (field breeding book) through authorized breeding organization Plemko s.r.o.

Statistical analyses

Statistical evaluation was carried out in program SAS 9.3 (SAS/STAT® 9.3, 2011). The basic statistics were computed with MEANS procedure. Generalized linear model with fixed effect of breed, housing, groups according legs formation and groups according udder formation was analysed. The most appropriate model was selected according Akaike information criterion. Tukey-Kremer test was used for detail comparison of differences between groups. Three groups of legs and udder formation characteristics were created according arithmetic means (AM) ± ½ standard deviations (s) (AM < –½s; AM = –½s to +½s; AM > + ½s). The model equation had following form:

$$Y_{ijklm} = \mu + BREED_i + HOUSING_j + LEG_k + UDDER_l + e_{ijklm}$$

where:

Y_{ijklm} .....dependent variable (average lactation at culling, average lifelong production, maximum amount of milk per lactation, fat%, kg fat, protein%, kg protein),

μ .....mean value of dependent variable,

$BREED_i$ .....fixed effect of breed (i = Czech Fleckvieh, n = 1650; i = Montbeliarde, n = 419; i = crossbreed of Czech Fleckvieh and Montbeliarde, n = 656),

$HOUSING_j$ ....fixed effect of housing (j = farm 1, n = 1636; j = farm 2, n = 1089),
LEG_k .....fixed effect group of leg evaluation (k < 74.61 points, n = 542; k = 74.61 – 81.90 points, n = 1183; k > 81.90 points, n = 1000),
$UDDER_l$ .....fixed effect group of udder evaluation (k < 76.94 points, n = 657; k = 76.94 – 81.75 points, n = 1029; k > 81.75 points, n = 1039),
e_{ijklm} .....random error.

Significance levels P < 0.05, P < 0.01 and P < 0.001 were used to evaluate differences between groups.

RESULTS

The average lactation at culling was 3.23 in both of the evaluated farms. The average lifelong milk production was 21018.50 kg, with maximal amount of 7947.06 kg milk per lactation. The average milk fat content was 3.75% (295.29 kg) per lactation. The average value of milk protein was 3.46% (273.78 kg) per lactation. The culled cows had the average evaluation of legs 78.30 points and of udder 79.34 points.

The model equation was significant (P < 0.001) for all the evaluated indicators and this equation explained from 1.4% (average lactation at culling) to 14.7% (fat kg) their variability. The significance of partial factors in used model added with the F-test results is presented in Tab. I.

The detail evaluation of GLM procedure is mentioned in Tab. II and Tab. III. The significantly higher average lactation at culling (0.35 lactation; P < 0.01) was observed in crossbred cows (X) compare to purebred (C). As expected, the highest value of maximal milk production was found in purebred (I) (184.04 to 796.57 kg; P < 0.01). The same tendencies, however non-significant, were evident for lifelong production indicators. The significantly higher values of milk fat and protein percentage content (0.03 to 0.17%; P < 0.01–0.05) were achieved in crossbreds, in comparison with purebred animals. On the other hand, the highest values of total fat (13.59 to 19.15 kg; P < 0.01) and protein (19.35 to 25.98kg; P < 0.01) content in kg were observed in purebred animals I.

The group of cows with the lowest total points for legs (<74.61 points) reached non-significantly better results for an average lactation at culling and for a lifelong production compared to the other groups. Contrary, the numerically highest maximal amount of milk per lactation (P > 0.05) was observed in the group of animals with legs evaluation >81.90 points. The highest values (P <0.05 to P < 0.01) of fat and protein (both in% and kg) were achieved in

I: *Basic statistics for model equation for evaluation of longevity and milk production indicators*

indicators	MODEL		breed		housing		legs evaluation		udder evaluation	
	r^2	P	F-test	P	F-test	P	F-test	P	F-test	P
ALC	0.014	<0.001	7.76	<0.001	0.58	0.446	2.59	0.075	8.70	<0.001
LP	0.019	<0.001	2.64	0.072	16.67	<0.001	1.96	0.141	16.15	<0.001
MAM	0.107	<0.001	33.04	<0.001	106.51	<0.001	0.43	0.654	26.23	<0.001
fat %	0.044	<0.001	28.09	<0.001	42.24	<0.001	6.93	0.001	5.02	0.007
fat kg	0.147	<0.001	15.12	<0.001	234.27	<0.001	4.33	0.013	20.33	<0.001
protein %	0.048	<0.001	6.93	0.001	52.08	<0.001	16.67	<0.001	4.40	0.012
protein kg	0.100	<0.001	33.12	<0.001	85.49	<0.001	3.08	0.046	24.82	<0.001

ALC – average lactation at culling; LP – lifelong production; MAM – maximal amount of milk per lactation

II: *Evaluation of breed, legs evaluation and udder evaluation effects on longevity and milk production parameters*

effect	level	ALC	LP	MAM
		LSM ± SEM	LSM ± SEM	LSM ± SEM
breed	C	3.10 ± 0.048^{A}	20571 ± 385.02	8065.74 ± 46.471^{A}
	I	3.34 ± 0.096	22488 ± 78.72	8249.78 ± 93.538^{B}
	crossbreed	3.45 ± 0.079^{A}	21564 ± 634.23	7453.21 ± 76.381^{A,B}
legs evaluation (points)	<74.61	3.41 ± 0.084	22400 ± 680.85	7869.29 ± 81.673
	74.61 - 81.90	3.30 ± 0.061	21428 ± 496.29	7947.00 ± 59.952
	>81.90	3.18 ± 0.066	20795 ± 533.18	7952.44 ± 63.824
udder evaluation (points)	<76.94	3.07 ± 0.078^{A,B}	19200 ± 633.29^{A,B}	7589.82 ± 77.927^{A}
	76.94-81.75	3.36 ± 0.065^{A}	21942 ± 527.62^{A}	7929.34 ± 63.099^{A}
	>81.75	3.45 ± 0.065^{B}	23480 ± 523.71^{B}	8249.56 ± 62.109^{A}

ALC – average lactation at culling; LP – lifelong production; MAM – maximal amount of milk per lactation; C….Czech Fleckvieh; I…. Montbeliarde; LSM – least square means; SEM – standard error of last square means.
$^{A, B}$ – values in columns with same letters differ significantly (P < 0.01).

III: *Evaluation of breed, legs evaluation and udder evaluation effects on milk production parameters*

effect	level	fat %	fat kg	protein %	protein kg
		LSM ± SEM	LSM ± SEM	LSM ± SEM	LSM ± SEM
breed	C	3.73 ± 0.011^{A}	298.44 ± 1.595^{A}	3.45 ± 0.005^{A}	276.71 ± 1.492^{A}
	I	3.71 ± 0.022^{B}	304.00 ± 3.211^{B}	3.45 ± 0.010^{a}	283.34 ± 3.003^{B}
	crossbreed	3.87 ± 0.018^{A,B}	284.85 ± 2.622^{A,B}	3.48 ± 0.009$^{A,.a}$	257.36 ± 2.452^{A,B}
legs evaluation (points)	<74.61	3.73 ± 0.019^{A}	290.74 ± 2.803^{a}	3.43 ± 0.009^{A,B}	268.05 ± 2.622^{a}
	74.61 - 81.90	3.76 ± 0.014^{a}	296.06 ± 2.058	3.46 ± 0.007$^{A,.a}$	273.58 ± 1.925
	>81.90	3.81 ± 0.015^{A,a}	300.48 ± 2.191^{a}	3.49 ± 0.007^{B,a}	275.77 ± 2.049^{a}
udder evaluation (points)	<76.94	3.79 ± 0.018^{a}	285.06 ± 2.675^{A}	3.47 ± 0.009^{a}	261.79 ± 2.502^{A}
	76.94-81.75	3.78 ± 0.015^{b}	297.04 ± 2.166^{A}	3.46 ± 0.007	273.11 ± 2.026^{A}
	>81.75	3.73 ± 0.014^{a,b}	305.19 ± 2.132^{A}	3.44 ± 0.007^{a}	282.50 ± 1.994^{A}

C….Czech Fleckvieh; I…. Montbeliarde; LSM – least square means; SEM – standard error of last square means.
$^{A, B}$ – values in columns with same letters differ significantly (P < 0.01).
$^{a, b}$ – values in columns with same letters differ significantly (P < 0.05).

animals with the best legs evaluation (group >81.90 point).

Generally the stronger influence was found in the evaluation of udder formation compared to legs formation. The highest average lactation at culling (0.09 to 0.36 lactation; P <0.01) was detected in animals with the highest udder evaluation (group > 81.75 point). The same tendencies (P <0.01) were also observed in the characteristics of average lifelong production (1538 to 4280 kg) and maximal amount of milk per lactation (320.22 to 650.74 kg). Better results in fat and protein percentages were achieved in the group with udder evaluation < 76.94 points (0.02 to 0.05%; P <0.05). The results of fat and protein content (kg) were similar to the trend described in lifelong production. The best results (8.15 to 20.71 kg; P < 0.01) were achieved in the group with udder evaluation > 81.75 point.

DISCUSSION

The evaluation of exterior has a close connection to longevity (Strapák *et al.*, 2004). According to these authors, the highest emphasis is given on legs and udder formation. The effect of breed was significant in evaluation of all the observed characteristics, except of a lifelong production. An effect of housing quality was significant for all the evaluated longevity and production traits except of average lactation at culling. The effect of these factors has been confirmed in the study of Strapák *et al.* (2008) or Onyiro and Brotherstone (2008).

"Effect of legs evaluation" group was significant only for evaluation of milk components, while "effect of udder evaluation" group was significant for all the longevity and production parameters. The effect of udder formation was also more important than legs evaluation in the study of Ondráková (2013). According to this author, the udder formation showed the strongest correlation to length of production life from all the complex characteristics of animal linear description. These results were also confirmed by Strapák *et al.* (2010), du Toit *et al.* (2012) and Fűrst (2008). Significantly higher average lactation at culling was observed in crossbred compared to purebred C and I. Also Strapák *et al.* (2004) confirmed higher longevity for crossbreeds compared to purebred Slovakian Pied cattle. The lifelong production was lower in crossbreds than in purebred population of I, because of higher genetic progress of milk production in purebred population. On the contrary, the potential heterose effect was manifested in fat and protein content percentages in crossbreeds. However, the results of fat and protein in kg were lower due lower milk production in crossbreeds. Also Hamann and Distl (2002) and Janžekovič *et al.* (2009) came to the same conclusion in their research in different breeds of cattle.

The factor of legs group was evaluated in the following part of this study. The best, however non-significant results in average lactation at culling and lifelong production were achieved in animals with the lowest points for legs. These findings are in oppose to the study Hamann and Distl (2002), Strapák *et al.* (2004) and Sewalem *et al.* (2005), which described the positive relationships between legs formation and longevity regardless to breed. The highest maximal milk yield was observed in animals with legs evaluation > 81.90 points. Also Pérez-Cabal (2006), and Čanji *et al.* (2008) confirmed that cows with better legs formation achieved higher average lactation at culling. Nevertheless, Sewalem *et al.* (2005) found that animals with inadequate legs formation had worse milk production and lower average lactation at culling, which is in accordance with our study. Significantly highest value of milk fat and protein (% and kg) were achieved by animals with the best legs evaluation.

The factor of udder group has proved to be the most important in the model equation. The highest average lactation at culling was computed for animals with the highest value in udder evaluation. The best results for lifelong production and maximal amount of milk per lactation were also observed in the group with

the highest value in udder evaluation. Animals with the lowest udder evaluation had the highest fat and protein percentages. The results of our study are in accordance with Strapák *et al.* (2008), Buenger *et al.* (2001), Powell and Van Raden (2003), and Van Raden (2004). These authors confirmed relationships between udder characteristics and longevity.

CONCLUSION

We can conclude that the influence of the udder on the total milk production and maximal amount of milk per lactation was significant. In the case of legs effect on evaluated traits was not found a significant influence. The higher average lactation at culling was found in crossbreds (X), compare to purebred C and I. The highest maximal amount of milk per lactation was detected in purebred C. Fat and protein (%) were significantly higher in crossbreds (X), while the fat and protein content (kg) were found to be highest in purebred I. The effect of legs group was statistically significant only for milk solid components assessment. On the other hand, effect of udder group was significant for all the longevity and production parameters. The cows with the lowest legs evaluation reached non-significantly the best results in average lactation at culling and lifelong production. The numerically highest maximal amount of milk per lactation was found in animals with legs evaluation > 81.90 points. The significantly highest udder evaluation was connected with the highest average lactation at culling. The positive relationship among lifelong production, maximal amount of milk per lactation and udder evaluation were also detected. The best results were achieved in cows with udder evaluation >81.75 points. These cows had simultaneously the highest milk yield. Based on the results described above, we can say there is the relationship between longevity, milk production and exterior. So, the animals with better exterior evaluation have in fact higher longevity, milk yield and higher content of solid components in milk. The results of this study also confirmed the influence of exterior evaluation on animal culling. Our results shows, that adequate formation of legs and udder have influence on longevity. For breeding purposes it's important to choose cows not only with high potential for milk production, but also for correct exterior parameters and formation of legs, resp. udder.

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