

PHENOTYPIC CORRELATIONS BETWEEN FEED INTAKE, FEED EFFICIENCY AND MILK PRODUCTION TRAITS IN POLISH FRIESIAN HEIFERS

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INTRODUCTION

Feed is a major component of milk production cost. In consequence, feeding strategies are aimed at minimising feed cost for a given level of production. However, in a selection directed on milk production, no attention has been paid to differences in feed costs between individual cows. The main difficulties results from breeding programmes, involving progeny testing of bulls under evaluation which is distributed across many herds, making such measurements both expensive and impractical (Simm *et al.*, 1991). Investigations suggest that selection on milk yield does not automatically increase feed intake of dairy cows (Korver, 1988). Feed intake, body weight and feed efficiency are moderately to highly heritable with h^2 between 0.2 – 0.8 (Averdunk *et al.*, 1988 ; Jensen *et al.*, 1991 ; Korver *et al.*, 1991 ; Persaud *et al.*, 1991).

The aim of this study was to estimate phenotypic correlations between feed intake, feed efficiency and milk production traits measured in growing and lactating heifers.

MATERIAL AND METHODS

Milk production and feed intake records were collected from 197 Polish Friesian growing and 109 lactating heifers housed and managed at the Institute of Genetics and Animal Breeding cattle farm. Twenty six Holstein bulls sired the animals used in the study.

Growing heifers. Feed intake was measured for heifers from 206 to 248 days of age. During the test period animals were housed in tying stalls and fed a diet of hay and concentrates, both offered *ad libitum*. The true test period lasted 28 days and was preceded by a 14-day-adaptation (pre-test) period. One kg of concentrate contained 860 g dry matter, 9.7 MJ net energy and 132-138 g crude protein. Heifers started the test period with a mean live weight of 184.0 kg. Daily feed intake was calculated as sum of hay and concentrate intake weighted by their dry matter, protein and energy content (estimated with INRA system). Feed conversion efficiency was calculated as the daily intake of dry matter (DM), crude protein (CP), protein digested in the small intestine (PDI) and feed unit for lactation (FUL), divided by daily gain in 28-day-test period. Body weight was measured at the start and end of the test period.

Lactating heifers. After calving heifers were maintained in tying stalls. Feed intake was measured from 100 to 128 days of lactation. Heifers were fed *ad libitum* a total mixed ration (TMR - containing maize silage 42.3% DM, grass silage 16.6% DM and concentrate 41.1% DM). The average dry matter content of the TMR was 40.7%, whereas it contained on average 95 g PDI and 0.94 UFL per kg dry matter. Milk yield and fat and protein content were recorded monthly during whole lactation and weekly four times during the test period from 100 to 128 days of lactation. Daily feed intake was calculated as TMR intake, weighted by their dry matter, protein and energy content. Feed efficiency was calculated as the daily intake of DM,

CP, PDI and UFL divided by daily milk during 28-day-test period.

RESULTS AND DISCUSSION

Table 1 presents means and standard deviations for some of the traits analysed. The live weight (LW) of heifers at the start of true test period was 184 kg and 219 kg at the end of the test. During the 28-day-test period daily weight gains averaged 1.25 kg. The average daily feed intake was 5,92 kg DM, 593 g PDI and 6,22 UFL. Heifers required approximately 4,9 kg DM, 491 g PDI and 5,15 UFL for 1 kg live weight gain. Average yield during 305-day-lactation amounted to 5643 kg of milk, 242.4 kg of fat and 190.4 kg of protein. The average daily feed intake of lactating heifers was 16.3 kg DM, 1502 g PDI and 15.2 UFL. The live weight of lactating heifers was 483 kg at 100 day of lactation and 489 kg at 128 day of lactation.

Table 1. Overall means and standard deviations for animal's performance traits

Traits	Growing heifers		Lactating heifers	
	mean	s.d.	mean	s.d.
DM intake (kg)	5.92	0.77	16.3	1.9
DM efficiency (kg/kg) ^A	4.90	0.75	0.90	0.15
PDI intake (kg)	0.59	0.08	1.50	0.19
PDI efficiency (kg/kg) ^A	0.49	0.08	0.083	0.013
UFL intake	6.22	0.81	15.2	2.0
UFL efficiency (UFL/kg) ^A	5.15	0.77	0.84	0.14
LW at the start of test period (kg)	184	23.6	483	34.2
LW at the end of test period (kg)	219	25.8	489	33.3
Milk yield (kg)	-	-	5643	932
Milk fat content (%)	-	-	4.30	0.40
Milk protein content (%)	-	-	3.38	0.21

^A DM, PDI, UFL intake divided by weight gain for growing heifers or divided by milk yield for lactating heifers

The phenotypic correlation coefficients between DM intake and CP intake in growing heifers and milk, fat and protein yield over a 305-day-lactation were 0.23 ; 0.20 ; 0.24 and 0.30 ; 0.31 ; 0.34 respectively (table 2). The results of the present study were more promising than reported by Nieuwhof *et al.* (1992). Cited authors obtained coefficients of phenotypic correlation between feed intake capacity in growing heifers and their further milk performance close to zero. In the present study phenotypic correlations between feed efficiency in growing heifers and milk, fat and protein yield as well as milk protein and fat content over a 305-day-lactation were generally low (-0.02 – 0.12). These results were similar to phenotypic estimates found by Nieuwhof *et al.* (1992).

Table 2. Phenotypic correlation coefficients between feed intake, feed conversion efficiency and milk production traits measured in growing heifers

Traits in growing heifers	305-day-lactation				
	Milk yield	Fat yield	Fat content	Protein yield	Protein content
DM intake	0.23*	0.20*	-0.02	0.24*	-0.01
CP intake	0.30**	0.31**	0.07	0.34**	-0.06
PDI intake	0.31**	0.31**	0.07	0.34**	0.06
UFL intake	0.25**	0.22*	-0.02	0.27**	0.01
DM efficiency	0.02	0.01	-0.02	0.01	0.01
CP efficiency	0.09	0.12	0.07	0.11	0.06
PDI efficiency	0.09	0.12	0.06	0.11	0.06
UFL efficiency	0.04	0.03	-0.01	0.04	0.01

** $p \leq 0.01$ * $p \leq 0.05$

Estimated in lactating heifers phenotypic correlations between feed intake capacity and milk performance over a 305-day-lactation are presented in table 3. Positive relationships were found between DM, CP, PDI and UFL intake and yield of milk, fat and protein over a 305 –day – lactation. Correlation coefficients were ranging from 0.23 to 0.45. The results corresponded to those published by Persaud *et al.* (1991), Van Elzakker and Van Arendonk (1993) and Oldenbroek *et al.* (1997). Cited authors found significant correlations between feed intake capacity and milk performance of 0.27 to 0.59.

In the present study phenotypic correlations found between feed efficiency and milk, fat and protein yield were moderately to highly negative (- 0.31 to - 0.67). Slightly lower, but positive phenotypic correlations for the content of protein and fat were found (0.26 to 0.53).

Table 3. Phenotypic correlation coefficients between feed intake, feed conversion efficiency and milk production traits measured in lactating heifers

Traits in lactating heifers	305-day- lactation				
	Milk yield	Fat yield	Fat content	Protein yield	Protein content
DM intake	0.25*	0.23*	0.04	0.23*	-0.04
CP intake	0.30**	0.37**	0.17*	0.33**	0.06
PDI intake	0.41**	0.45**	0.16	0.44**	0.07
UFL intake	0.29**	0.26**	0.02	0.28**	-0.05
DM efficiency	-0.67**	-0.46**	0.28**	-0.52**	0.42**
CP efficiency	-0.60**	-0.34**	0.36**	-0.42**	0.49**
PDI efficiency	-0.57**	-0.31**	0.38**	-0.38**	0.53**
UFL efficiency	-0.66**	-0.46**	0.26**	-0.52**	0.42**

** $p \leq 0.01$ * $p \leq 0.05$

CONCLUSIONS

In growing heifers correlations found between feed intake capacity and their subsequent milk performance were statistically significant. Young heifers with good feed intake may be predisposed to attain high yield of milk, fat and protein.

Estimates for correlations between feed conversion efficiency and milk production traits were found low and not significant.

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