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PHENOTYPE CORRELATIONS OF LINEAR ASSESSMENT SCORES OF TYPE AND PRODUCTION TRAITS OF SIMMENTAL COWS

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Abstract: Determining the degree of correlation between two or more traits depends to a large extent on their manifestation. The knowledge of genetic and phenotypic correlations between body characteristics of the animal and product characteristics can help define the breeding goal, but also to define and harmonize the assessment criteria. Although the phenotypic and genetic correlations between the traits of body development and type and the milk yield show different degrees of variation, they should be taken into account in the final assessment of the breeding value of the animal so that the selection programs are more comprehesively defined. The examination of phenotypic correlations of linear assessment scores of the type, milk and fertility traits was performed on a total of 303 cows of the Simental breed in the first three lactations. The examination of phenotypic correlations included the following milk performance properties in the first three standard lactations: milk yield, milk fat content, milk fat yield, yield of 4% corrected milk; also fertility traits: age at current calving and service period in each lactation; while the linear type scoring included a group of traits: type or frame, muscularity, fundament, udder.

Key words: correlation, milk performance, fertility, type traits, Simmental breed.

Introduction

The main goal of the breeding and selection work is to create new generations that will be superior to the previous ones in terms of their production results and show greater productive effects in the production of milk and meat. For these reasons, it is necessary in the selection work to know the breeding value of parental couples, as well as the degree of heredity and the correlation of important traits (*Pantelić 2006*).

Phenotypic correlation of milk and fertility traits is very important when it is desirable to perform comparative selection for several properties, and even more important for indirect selection in conditions where some properties can not be directly promoted. At the same time, opportunities for increasing the success of selection by making early selection conclusions and decisions are created (*Pantelić et al., 2007*). In these studies, the age of calving was in a negative phenotypic correlation with all production indicators: milk yield -0.023, % of milk fat -0.005, quantity of milk fat -0.023, and production of 4% FCM -0,023. The mutual phenotypic correlation of age at calving and service period was slightly positive 0.047. The service period was also in a negative correlation with the milk yield traits, except for the percentage of milk fat 0.001, as well as the duration of lactation 0.329.

Hermas et al. (1987) have found coefficients of phenotypic correlations between milk properties in standard lactation and some fertility properties. Phenotypic correlations had the following values: milk yield - service period 0.19, milk yield - age at calving -0.01, milk fat, kg - service period 0.17, milk fat, kg - age at calving 0.06, milk fat, % - service period -0.03, and milk fat, % -age at calving 0.07.

Moore et al. (1991) provide data on the values of the coefficients of the phenotypic correlations between production of milk and milk fat in standard lactation with age at calving of 0.20 and 0.21, respectively.

Stojić (1996) has calculated the coefficients of phenotypic correlations between milk properties in standard lactation and age at calving (AC) and service period (SP). Correlation coefficient values were: milk yield - AC 0.034; milk yield - SP 0.095; milk fat, % - AC 0.034; milk fat, % - SP -0,032; milk fat, kg - AC 0.045; milk fat, kg - SP 0.072; yield of 4% FCM - AC 0.042; yield of 4% FCM - SP 0.085.

Marković (1999) has noted the values of phenotypic correlations between milk properties. The results of phenotypic correlations ranged from -0.35 between milk yield and milk fat content up to 0.96 between milk yield and 4% FCM.

Linear type properties are the basis of all modern classification systems, and represent the basis of all systems for describing dairy cows. Linear classification is based on measures/measurement of individual characteristics of the type instead of giving opinions. It describes the degree of presence of a trait, and not desirability (*Pantelić et al., 2011*).

Body development and type are very important indicators of cow's production capabilities, their ability to consume sufficient amounts of food, give high-quality milk, reduce energy consumption in production and prolong production, giving more number of offspring.

Živanović (2002) has examined the variability of the linearly assessed type traits and milk yield of the primiparous Black and White heifers on a sample of 2,976 cows. Negative genetic correlations between milk properties and linearly

assessed type traits have ranged from -0.241 to -0.856, for a large number of investigated properties. Positive genetic correlations have ranged from 0.544 to 0.744.

Analyzing the production and body traits of Holstein cows, *Koenen and Groen (1998)* have established the strength of genetic and phenotypic correlations between the type and conformation properties. The values of the coefficients of the phenotypic correlations have ranged from -0.28 (the depth of the udder and the depth of the body) and 0.95 (body wight and pelvic height), and genetic correlation from -0.49 (body depth and udder depth) to 0.77 (body weight and chest girth).

By examining the phenotypic and genetic correlations of the milk yield traits and the type of bull dams of the Holstein Friesian breed, *Pantelić et al. (2012)* have found negative phenotypic correlations between milk production and type traits. Phenotypic correlations have ranged from -0.12 (position of the rear legs, the side view) to -0.01 (pelvic height and body depth), and positive from 0.03 (position of the rear teats) to 0.23 (central ligament). Phenotypic correlations between the percentage of milk fat and the type traits have ranged from -0.08 (position of the front teats) to 0.14 (pelvic height).

Material and method

The examination of phenotypic correlations of linear assessment of the type, milk and fertility characteristics was performed on a total of 303 cows of the Simental breed in the first three lactations. The examined throats were cultivated in different individual farms, but can be said mainly in very similar conditions of keeping and eating. The cows were kept in large numbers in stables with a connected holding system, on long and medium-sized bays with straw. The diet was based on hay and seedling alfalfa, less common grass, silage the whole corn plant and mainly concentrated concentrates. The husband was machine-made, mostly in buckets, and milk was stored in lacto-frys until delivery. Productivity control was carried out by the princes of the AT4 control of productivity by the breeding organizations, in which the measurement of the milk is done only during the morning or only during the evening moon on the control day (alternative method), but using their results must be mathematically corrected to the reference method.

The examination of phenotypic correlations of linear type scores, milk and fertility traits was performed on a total of 303 cows of the Simental breed in the first three lactations. The examined animals were reared on different individual farms, but mainly in very similar conditions of housing and nutrition. The cows were kept mainly in stables with a tied system, on long and medium-sized beds with straw. The diet was based on hay and alfalfa silage, to lesser extent grass was used, whole maize plant silage and mixtures of concentrates. The milking was

carried out using the machine, mostly into buckets, and milk was stored in lacto - freeze storage until delivery. Productivity control was carried out by the principles of the AT4 control of productivity by the breeding organizations, the milk quantity was measured only during the morning or only during the evening milking in the test day (alternative method), but the results obtained in this way must be mathematically corrected to the reference method.

Linear assessment of the type and body development of the examined cows of the Simental breed was carried out according to the established criteria, individually or during the animal evaluation, with an immediate insight into the appearance and condition of the animals. Each trait is judged individually using wide range of grades from 1 to 9, whereby the qualities in the evaluation are grouped as follows: frame, muscularity, fundament and udder. In such a way, a greater accuracy is achieved both of individual scores and of the overall external appearance. Although a linear score does not describe the desirability of a feature, grade 9 will be either the most desirable or least desirable of two possible extremes.

The examination of phenotypic correlations included the following milk performance traits in the first three standard lactations:

- Milk yield, kg;
- Milk fat content, %;
- Milk fat yield, kg;
- Yield of 4% fat corrected milk, kg.

In addition to the milk performance traits for each cow, the age at current calving and the service period in each lactation were determined, while the linear type score included a group of traits:

- Type or frame;
- Muscularity;
- Fundament;
- Udder.

Phenotypic correlation between milk performance traits, fertility traits and linear type scores was tested using the linear correlation method, and it was discussed based on the Roemer-Orphal classification.

Phenotypic correlations were calculated according to the formula:

$$rp_{xy} = \frac{Cov_{Pxy}}{\sqrt{\sigma^2_{Px} \times \sigma^2_{Py}}}$$

The symbols have the following meanings:
rPxy = coefficient of phenotypic correlation between traits *x* and *y*
CovPxy = phenotypic covariance between traits *x* and *y*
σ^2Px = phenotypic variance of trait *x*
σ^2Py = phenotypic variance of trait *y*

Results and Discussion

Phenotypic correlations are determined both by genetic and external factors. If the environmental conditions in related animals were identical, then the phenotypic value of the correlations would be equal to the genetic one. However, as there are no identical conditions in the practical cattle breeding, the values between these correlations are also different. If the external environment conditions are more stable or less variable, the degree of correlation between the phenotypes of the animals would be greater *(Petrović and Pantelić, 2015*).

Table 1. Coefficients of phenotypic correlations (r_{xy}) between the studied indicators of milk performance traits, fertility and type in the first lactation.

Indicators	A	B	C	D	E	F	G	H	I
Milk yield, kg **(A)**	\								
Milk fat content, % **(B)**	0.14*	\						* - P<0.05	
Milk fat yield, kg **(C)**	0.98*	0.32*	\						
Yield of 4%FCM, kg **(D)**	0.99*	0.25*	1.00	\					
Age at calving, days **(E)**	0.23*	0.10	0.24*	0.24	\				
Service period, days **(F)**	0.03	-0.02	0.03	0.03	0.04	\			
Frame **(G)**	0.27*	0.14*	0.28*	0.28*	0.15*	0.05	\		
Muscularity **(H)**	0.29*	0.18*	0.31*	0.30*	0.22*	0.06	0.71*	\	
Fundament **(I)**	0.28*	0.15*	0.30*	0.29*	0.17*	-0.01	0.66*	0.80*	\
Udder **(J)**	0.30*	0.15*	0.32*	0.32*	0.20*	0.01	0.66*	0.78*	0.76*

Table 2. Coefficients of phenotypic correlations (r_{xy}) between the studied indicators of milk performance traits, fertility and type in the second lactation.

Indicators	A	B	C	D	E	F	G	H	I
Milk yield, kg **(A)**	\								
Milk fat content, % **(B)**	0.03	\						* - P<0.05	
Milk fat yield, kg **(C)**	0.98*	0.21*	\						
Yield of 4%FCM, kg **(D)**	0.99*	0.14*	1.00*	\					
Age at calving, days **(E)**	0.19*	0.06	0.20*	0.20*	\				
Service period, days **(F)**	0.06	-0.06	0.05	0.05	0.03	\			
Frame **(G)**	0.32*	0.01	0.32*	0.32*	0.16*	0.09	\		
Muscularity **(H)**	0.26*	-0.06	0.25*	0.25*	0.21*	0.13*	0.71*	\	
Fundament **(I)**	0.25*	-0.02	0.24*	0.24*	0.14*	0.13*	0.66*	0.80*	\
Udder **(J)**	0.31*	-0.01	0.30*	0.30*	0.17*	0.09	0.66*	0.78*	0.76*

The coefficients of phenotypic correlations (r_{xy}) between the studied parameters of milk performance traits, fertility and type in the first three standard lactations are shown in Tables 1-3.

Table 3. Coefficients of phenotypic correlations (r_{xy}) between the studied indicators of milk performance traits, fertility and type in the third lactation.

Indicators	A	B	C	D	E	F	G	H	I
Milk yield, kg **(A)**	\								
Milk fat content, % **(B)**	-0.08	\						* - P<0.05	
Milk fat yield, kg **(C)**	0.98*	0.13*	\						
Yield of 4%FCM, kg **(D)**	0.99*	0.04	1.00*	\					
Age at calving, days **(E)**	0.14*	-0.10	0.12*	0.13*	\				
Service period, days **(F)**	0.13*	0.03	0.13*	0.13*	0.10	\			
Frame **(G)**	0.29*	-0.11	0.26*	0.28*	0.18*	0.10	\		
Muscularity **(H)**	0.24*	-0.07	0.22*	0.23*	0.24*	0.04	0.71*	\	
Fundament **(I)**	0.22*	-0.08	0.20*	0.21*	0.18*	0.08	0.66*	0.80*	\
Udder **(J)**	0.26*	-0.02	0.26*	0.26*	0.18*	0.02	0.66*	0.78*	0.76*

Mutual positive and full phenotypic correlation between the yields of milk, milk fat and 4% fat corrected milk was established in all three lactations with the coefficient of correlation ranging from 0.98 to 0.99. Low and mainly positive correlation was established in indicators milk yield and milk fat content (0.13, 0.21, 0.32).

Low and generally positive phenotypic correlation was recorded in all three lactations, both for milk performance and fertility indicators, but also for fertility and type indicators. The coefficient of phenotypic correlations ranged from 0.03 between the milk yield and the duration of the service period in the first lactation (Table 1) to 0.24 between the yield of 4% FCM and the age at first calving.

The phenotypic correlation of the indicators milk yield and the average type score was moderate and generally positive. The interval of variation of the coefficient of correlation between milk yield and the properties of the type were in the range from 0.22 for milk yield and fundament score (Table 3) to 0.32 milk yield and score for body frame (Table 2). Weak and mainly negative correlation was established between the properties of the type and the milk fat content for cows in the second and third lactation. The coefficient of phenotypic correlation ranged from -0.01 milk content and udder score (Table 2) to -0.11 milk fat content and frame score (Table 3).

A negative phenotypic correlation between milk production and percentage of milk fat, and a positive between the yield of milk and the quantity of milk fat, or 4% of FCM in their researches, was found by a number of authors: *Moore et al. (1991)* and *Markovic (1999).* Negative phenotypic correlations between age at calving and milk production in their researches were established by *Hermas et al. (1987)* and *Pantelić et al (2007).* Unlike them *Moore et al. (1991)* and *Stojić (1996),* provide data on the positive values of the coefficient of phenotypic correlation of the above mentioned properties.

Determination of the degree of association/correlation of two or more traits depends to a large extent on their expression. The knowledge of genetic and phenotypic correlations between body properties of animals and production performance traits can help define the breeding goal, but also to define and harmonize the assessment criteria. Although the phenotypic and genetic correlations between the body development traits and the type and the milk yield show different degrees of variation, they should be taken into account in the final assessment of the breeding value of the animal so that the selection programs become more comprehensive.

Conclusion

The knowledge of the phenotypic association of milk and fertility traits with linear type scores is very important in the selection work, where, in addition to high production, good health is expected as well as the long productive life of the animals in the herd.

In this study, the positive and full phenotypic correlation between the yields of milk, milk fat and 4% fat corrected milk was established in all three lactations, as well as the low and mostly positive correlation between the indicators of milk yield and the milk fat content. Low and generally positive phenotypic correlation was recorded in all three lactations and for milk and fertility indicators, but also for fertility and type indicators. Phenotypic correlation between the milk yield indicator and average type score was medium strong and generally positive for the yield traits and weak and mostly negative between the type properties and the milk fat content.

The phenotypic correlation of the examined properties shows that when selecting both breeding heifers and semen for the fertilization of cows and heifers, the type traits must be taken into account, as this, in addition to the selection based on milk performance, shall contribute to the realization of higher milk production and faster genetic improvement of our population.

Fenotipske korelacije linearnih ocena tipa i proizvodnih osobina krava simentalske rase

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Rezime

Poznavanje fenotipske povezanosti osobina mlečnosti i plodnosti, sa linearnim ocenama tipa je veoma značajno u selekcijskom radu, gde se pored visoke proizvodnje, očekuje dobro zdravlje kao i dug produktivni život grla u stadu.
U ovom istraživanju medjusobna pozitivna i potpuna fenotipska povezanost prinosa mleka, mlečne masti i 4% mast korigovanog mleka ustanovljena je u sve tri laktacije, kao i niska i uglavnom pozitivna povezanost pokazatelja prinosa i sadržaja mlečne masti. Niska i uglavnom pozitivna fenotipska povezanost utanovljena je u sve tri laktacije i za pokazatelje mlečnosti i plodnosti, ali i za pokazatelje plodnosti i tipa. Fenotipska povezanost pokazatelja mlečnosti i prosečnih ocena tipa je bila srednje jaka i uglavnom pozitivna za osobine prinosa i slaba i uglavnom negativna izmedju osobina tipa i sadržaja mlečne masti.

Fenotipska povezanost ispitivanih osobina pokazuje da se prilikom odabira kako priplodnih junica, tako i semena za oplodnju krava i junica, mora povesti računa i o tipskim karakteristikama, jer će to pored odabira po mlečnosti doprineti ostvarenju veće proizvodnje mleka i bržem genetskom unapredjenju naše populacije.

Ključne reči: korelacije, mlečnost, plodnost, osobine tipa, simentalska rasa.

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