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EVALUATION OF PHENOTYPIC AND GENETIC PARAMETERS RELATED TO CLASSIFICATION BY TYPE AND PRODUCTIVITY OF COWS OF THE DAIRY POPULATION IN BULGARIA

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Abstract: Type classification on was performed for cows of the dairy population in Bulgaria by using experimental linear-descriptive system which includes five group of traits – general appearance milk forms, body capacity, legs and hoofs and milk system. Cows of 20 different breeds and kinds of crosses were assessed by the methodology applied in Canada and it is applied in Bulgaria at the recommendation of a FAO commission in connection with a conducted experiment. An object of the study were 1972 cows and logically the cows of Holstein-Friesian breed originating from USA, Canada and Israel had the highest score. The phenotypic correlations between the end score and the groups of traits had high values - from 0.654 to 0.964 and those with the milk productivity (milk and butterfat) varied from -0.123 to 0.606. The heritability of the type traits had low values - from 0.002 to 0.213 and corresponded with those obtained by other authors. The variance analysis for the end score showed that the age at first calving, the year ($P<0.05$) and the herd and breed ($P<0.001$) had a significant effect.

Key words: classification by type, correlations, heritability, cows of dairy breeds

Introduction

It is considered that the animal conformation is formed as a result of long adaptation reactions of animal organism and reflects the main physiological functions under concrete conditions of environment. Therefore, the relationship between productive qualities and constitution should be studied not at the basis of mass statistics, but only by taking into account the concrete conditions for normal functioning.

Some authors give a priority to the evaluation by type in the general system for dairy cattle improvement and other authors consider it only as necessary for

elimination of possible anomalies influencing their health state *(Atkeson et al., 1969; Boldman at al., 1992)*.

The system that in the last decades contributed to considerable improvement of Holstein-Friesian population in the USA and Canada is the base of comparison with the "perfect" functional type. For successful evaluation of the animals at least three prerequisites are necessary: exact knowledge of the "perfect" type accepted as a breeding criterion; location and name of the different animal parts and capacity for correct judgment of strengths and weaknesses of the type and constitution *(Yonikovski, 1989)*.

The knowledge of mutual relationships between the traits is of great importance to breeding by type.

In the last decades many researchers calculated phenotypic and genetic correlations between the end score and the tens of traits that compose it; in most of cases they were about 0.5-0.7. However, those between the end score and the five groups of traits – general appearance, milk forms, body capacity, legs and hoofs and milk system were higher - 0.7 to 0.9 on average *(Yonikovski, 1989)*. Some authors calculated also low negative correlations between the traits of hoofs and fore udder of -0.02 to 0.17 *(Freeman et al.,1955; Mc Clintock et al., 1979)*.

The improvement of most traits of the milk system results also in increase of milk yield and vice versa, the breeding for the latter ought to have as a result a more perfect type.

On the other hand, the coefficients of heritability (h^2) and their variation determine their potential importance to breeding. The traits that characterize the cow type, with rare exceptions, have low h^2 values. For instance, for the different breeds and kinds of crosses in Bulgaria they vary from 0.002 to 0.213 *(Yonikovski, 1989)* and do not differ significantly from those of the other authors *(Butcher et al., 1963; Hansen et al., 1969; Legates, 1971; Cassell et al., 1973; Gendler et al, 1997; Van Niekerk et al., 2000)*. It is possible to predict breeding values through multi-factor models, which include a great number of type traits, but it is necessary to pay special attention to those with a very low h^2 and/or variation.

The objective of this study was the classification by type and evaluation of some phenotypic and genetic parameters associated with the type and milk productivity of cows from the dairy population in Bulgaria.

Materials and Methods

A number of 1972 cows from 20 different breeds and kinds of crosses at 1st lactation from 60 to 190 days after their calving were classified. The cows were from 43 farms located in all the country. The purebreds were from the Holstein-Friesian breed from the USA, Canada and Israel and the Bulgarian Rhodope cattle

and the other 16 groups were different crossbreds of the Bulgarian Red cattle with other breeds of European and American origin coded in the following way:

a/ Crossbred cows from the FAO experiment – 8 experimental groups

- Bulgarian Red cattle (BRC) code 01
- Crossbreds F1 of Angler x BRC 02
- Crossbreds F1 of Red Danish with B8RC 03
- Crossbreds F1 of Canadian Red-and-white Holstein-Friesian cattle x BRC 04
- Crossbreds F1 of Norwegian Red cattle x BRC 05
- Crossbreds F1 of Estonian Red cattle x BRC 06
- Crossbreds F1of Swedish Red-and-white cattle x BRC 07
- Crossbreds F1 of Finnish Ayrshire cattle x BRC 08

b/ Cows with other breed belonging – 12 groups

- American and Canadian Holstein-Friesian cattle (HFC) 09
- Israeli Holstein-Friesian cattle 10
- Crossbreds F_1 of HFC with BRC 11
- Crossbreds R_1 of HFC with BRC 12
- Crossbreds R_2 of HFC with BRC 13
- Crossbreds F_1 of HFC with Polish Black-and-white Friesian cattle (PBWFC) 14
- Crossbreds R_2 of HFC with Danish Black-and-white Friesian cattle (DBWFC) 15
- German Black-and-white of genotype 30 16
- German Black-and-white of genotype 31 17
- Crossbreds F_1 of American Brown cattle (ABC) with Bulgarian Brown cattle (BBC) 18
- Crossbreds R_1 of ABC with BBC 19
- Bulgarian Rhodope cattle 20

The experimental linear descriptive system was applied through comparison of the cows with a "perfect" type and containing five groups of traits: general appearance (15), milk forms (15), body capacity (15), legs and hoofs (25) and milk system (30). All groups of traits contain detailed description elaborated and suggested by Prof. Burnside (Canada) for assessment of the cows in connection with a FAO experiment conducted for development of a synthetic dairy population in Bulgaria *(Yonikovski, 1989)*.

To calculate the average scores the following general linear mixed model was used:

$Y=Xb+Zn+e$

Y – vector of observations (with length of number of measurements);

X, Z – matrices of observations;
b – unknown vector including fixed effects;
n – vector of random effects;
e – random vector (error of model);

The heritabilities were calculated through a linear genetic mathematical model including the factors of sire, year, herd and season.
The model has the following kind:
Yijklm=M+Si+Aj+Bk+Ce+lijkem
Where:
M – total average;
Si – effect of random factor of sire;
Aj – fixed effect reflecting the influence of herd;
Bk – fixed effect reflecting the influence of year;
Ce – fixed effect reflecting the influence of season;
lijkem- error of model.

The distribution of cows according to the obtained end score in the classification was the following:
Excellent score – 90+
Very good – 85-89
Good plus - 80-84
Good - 75-79
Poor - 65-74
Very poor - under 64

Results and Discussion

For the different groups of traits and end score the values of all groups of cows were the following: an average of 12.28 for general appearance; 12.35 for milk forms; 12.32 for body capacity; 20.34 for legs and hoofs; 24,63 for milk system and 81.94 for average end score.

The highest scores in the classification for the groups of traits, as well as for the end score were obtained by the HF cows from Israel (84.73), USA and Canada (84.09), German Black-and-white from genotype 30 (83.47), R_1 HF with BRC (83.13) and so on, the cows F_1 of BRC with Angler bulls having the lowest score (80.27). The significance of the differences in scores in most cases was at $P<0.001$ and a small part of them at $P<0.01$ and 0.05. The distribution of the cows according to classes formed by the end score had naturally the same sequence. The phenotypic and genetic correlations between the traits with end score and that of the latter with the milk productivity are presented in Tables 1 and 2 and the

heritabilities in Table 3. The data in Table 1 shows that all correlations between the end score and the five groups of traits were positive and high. Similar results were obtained also by *Renie and Raithby (1955)*, *Atkeson et al. (1969), Brotherstone (1994)* and others for scores between the end one and eight traits including the five traits in our study (0.78 to 0.84).

Table 1. Phenotypic and genetic correlations of the end score with the groups of traits

Code of groups	n	End score	Phenotypic correlations					Genetic correlations				
			General appearance (d)	Milk forms (b)	Body capacity (c)	Legs and hoofs (d)	Milk system (e)	a	b	c	d	e
0.1-08	823	81.15	0.91	0.83	0.86	0.79	0.80	0.98	0.99	0.99	0.99	0.99
0.1-19	1863	81.94	0.88	0.87	0.89	0.83	0.77	0.99	0.99	0.99	0.99	0.99
0.9-17	814	83.20	0.94	0.87	0.89	0.83	0.81	0.99	0.99	0.99	0.99	0.98
18и19	206	80.71	0.91	0.81	0.79	0.73	0.75	0.99	0.96	0.99	0.93	0.99
20	109	81.26	0.93	0.92	0.86	0.84	0.87	-	-	-	-	-

The high correlations confirmed the assumption of *Atkeson et al. (1969)* that the end score and that for the five groups of traits and particularly for the general appearance tend to be almost equivalent, which was demonstrated by the way, in which the expert classifiers act, i.e. they give first the end score and after that they evaluate the other traits. The phenotypic correlations between end score and milk productivity for the different groups of cows were 0.120 to 0.342 (Table 2). Mainly low to medium phenotypic correlations were obtained also by *Liang et al. (1967), Norman et al. (1972)*, *Dal Zotto et al. (2006)* and others. Low negative correlations were also obtained between some more distant traits.

Table 2. Phenotypic correlations of the end score with the milk productivity

Code of cow groups	n	Average end score	Milk productivity		Phenotypic correlations	
			Milk (a) kg	Butterfat (b) kg	a	b
Average (01-08)	823	81.15	3722	140.1	0.284	0.233
Average (01-19)	1863	81.94	3990	146.7	0.342	0.316
20	109	81.26	3121	148.0	0.120	0.180

The heritabilities of the five groups of traits and the end score (Table 3) were 0.002 to 0.207. Low to medium scores for h^2 were also obtained by many other authors having worked with Jersey, Holstein-Friesian and other breeds *(Van*

Niekerk et al., 2000; Gendler et al., 1997; Pedersen, 1996; Boldman et al., 1992; Meyer et al., 1987).

Table 3. Heritability of the traits of type and constitution

Traits according to the system of scores	Coefficient of heritability (h^2) for the cows from:			
	All experimental groups	FAO experiment	Purebred Holstein-Friesian and their crossbreds	Crossbreds of American Brown with BBC
General appearance	0.174	0.059	0.207	0.107
Milk forms	0.177	0.060	0.202	0.110
Body capacity	0.184	0.063	0.196	0.068
Legs and hoofs	0.184	0.70	0.202	0.092
Milk system	0.164	0.057	0.185	0.002
Total score	0.196	0.071	0.213	0.073

The analysis of variance showed that the end score was influenced highly significantly by the breed and herd of cows (0.001) and by the year and age at 1st calving at degree 0.05.

Conclusion

The cows of the Holstein-Friesian population reared in Bulgaria were superior to all other cows according to the end score, as well as according to the groups of traits characterizing the type and constitution. The phenotypic and genetic correlations for all traits of the cows classified by type were high and the phenotypic ones between the end score and milk productivity were low to medium. The values of the coefficient of heritability for all traits were low and among them h^2 was the highest for the end score of the cows of Holstein-Friesian population (0.213 as against 0.002 for the milk system of the brown population).

Ocena fenotipskih i genetskih parametara koji se odnose na klasifikaciju i proizvodnost mlečne populacije krava u Bugarskoj

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Rezime

Klasifikacija tipa krava u okviru mlečne populacije u Bugarskoj je izvedena korišćenjem linearnog-deskriptivnog sistema koji uključuje pet grupa

osobina – opšti izgled, telsni kapacitet, noge i papci i sistem muže. Krave 20 različitih rasa i melezi su ocenjivani metodologijom primenjenom u Kanadi, i koja je preporučena za primenu u Bugarskoj od strane FAO komisije u vezi sa izvedenim ogledom..

Predmet ispitivanja su bile 1972 krave i krave holštajn-frizijske rase poreklom iz SAD, Kanade i Izraela su imale najviše ocene.

Fenotipske korelacije između krajnje ocene i grupa osobina su imale visoke vrednosti – od 0.654 do 0.964 i osobina mlečnosti (mleko i mlečna mast) su varirali između -0.123 i 0.606.

Heritabilitet osobina tipa je imao niske vrednosti od 0.002 do 0.213 i u saglasnosti je sa vrednostima koje su dobili drugi autori.

Analiza varijanse za krajnu ocenu je pokazala da su uzrast pri prvom telenju, godina ($P<0.05$) i stado i rasa ($P<0.001$) imali signifikantan uticaj.

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