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The Power of the Influence of the Genotypes of DNA Markers on the Indicators of Milk Production of Cows

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Abstract

The purpose of the work was to study the power and reliability of the influence of the genotypes of kappa-casein (CSN3), diacylglycerol O-acyltransferase (DGAT1), somatotropin (GH), prolactin (PRL) on the indicators of milk production of black-and-white cattle. It was revealed that the CSN3 genotype had the greatest significant influence on the mass fraction of protein in milk, the proportion of its influence was η2 = 0.353 (Ffactual= 40.323; P<0.001) in first-calf heifers and it was η2= 0.140 (Ffactual= 13.400; P<0.001) in full-aged cows. There was also found an influence on milk protein yield that was η2= 0.074 (Ffactual= 5.882; P<0.01) and η2= 0.039 (Ffactual= 3.390; P<0.05). The DGAT1 genotype had a highly significant effect (P<0.001) on the fat mass fraction in milk for the 1st lactation η2= 0.189 (Ffactual= 17.202), for the 3rd lactation η2= 0.109 (Ffactual= 10.101). According to the somatotropin gene, a significant degree of influence of the genotype was revealed in full-aged cows only by milk yield per lactation η2= 0.057 (Ffactual= 4.949; P<0.01), and by the prolactin gene in terms of fat content of milk η2= 0.044 (Ffactual= 3.822; P<0.05). The desired allele B of the CSN3 gene has a significant effect only on the mass fraction of protein η2= 0.342 with the maximum value of the Fisher criterion that is Ffactual= 26.489 (P<0.001), and the allele K of the DGAT1 gene on the mass fraction of fat in milk η2= 0.163 (Ffactual= 17.305; P<0,001) and the V allele of the somatotropin gene on milk protein yield η2= 0,097 (Ffactual= 3.641; P<0.05). The genotypes CSN3 and DGAT1 have the widest influence on the indicators of milk production of cows.

Keywords: Genotype; CSN3; DGAT1; GH; PRL; Allele; Proportion of the influence; η2; indicators of milk production

Introduction

Effective selection work in dairy cattle breeding is possible only with the integrated use of zoo technical methods and modern DNA technologies. The use of molecular genetic methods for early prediction of the magnitude and direction of the productive qualities of an individual increases the rate of breeding progress by half and contributes to obtaining a significant economic effect [1]. The use of genetic markers in cattle breeding responsible for milk production will improve the economically useful characteristics of cows. Alleles of genes of milk proteins; hormones and enzymes are considered as potential DNA markers of milk production and milk quality in cattle. Some of these markers are genes for kappa-casein and diacylglycerol O-acyltransferase; somatotropin; prolactin [2-3]. Nowadays a special attention is paid to the gene locus of one of the main milk proteins that is kappa-casein. It is known that allelic variants of the milk protein of kappa-casein are connected with indicators of protein content of milk; and the yield of milk protein by the technological properties of milk [4-7]. Diacylglycerol O-

acyltransferase (DGAT1) gene involved in fatty acids metabolism. DGAT1 gene of cattle is mapped to the centromeric side of chromosome 14. Studies of Russian and foreign authors have revealed that this mutation significantly affects the milk production of cows; in particular; the milk yield and fat content of milk. At the same time it has been established that allele A is associated with high milk production and allele K is associated with a high content of mass fraction of fat in milk [8-11]. The use of hormone genes - prolactin (PRL) and somatotropin (GH) as DNA markers of milk production in cattle is connected with the participation of proteins encoded by them in the regulation of lactation; synthesis and secretion of various constituents of milk [12-13]. Thus; cows with the BB genotype for the prolactin gene have a higher fat content of milk and; accordingly; have a higher yield of milk fat and protein [14-15]. The influence of various allelic variants of the GH gene on the indicators of milk production of cows (milk yield; fat and protein content of milk) was also determined [16-18]. The issue of improving the productive qualities of cows is a daily problem and is based on a combination of genetic and non-genetic factors. As a consequence; an important problem arises of studying the proportion of the influence of different genotypes of DNA markers on the productive qualities of dairy cattle. In this regard; the purpose of the work is to study the power and reliability of the influence of the genotypes of kappa-casein; diacylglycerol O-acyltransferase; somatotropin and prolactin on the indicators of milk production of black-and-white cattle.

Materials and Methods

In order to conduct the research and genotyping for kappa-casein; diacetylglycerol O-acetyltransferase; somatotropin; prolactin 151 first-calf heifers and 168 full-aged black-and-white cows; from which blood samples were taken and DNA samples were isolated; were selected in the conditions of the breeding reproducer of OOO «Dusym» (Dusym; LLC) of Atninsky District in the Republic of Tatarstan. The material for molecular DNA testing was the venous blood of animals. DNA isolation was carried out using the Magnosorb kit (Interlabservice; Moscow); according to the manufacturer's instruction. Genotypes CSN3; DGAT1; GH; PRL were determined by PCR-RFLP (restriction fragment length polymorphism). Amplification was carried out on a Tertsik amplifier (DNA-technology; Moscow). Depending on presence of alleles A and B of the CSN3 gene; genotypes were divided into three groups (AA; AB; BB); alleles A and K of the DGAT1 gene; genotypes were divided into three groups (AA; AK; KK); alleles V and L of the GH gene; genotypes were divided into three groups (VV; VL; LL); alleles A and B of the PRL gene; genotypes were divided into three groups (AA; AB; BB). Data on milk production for 1st and 3rd lactation of cows with different genotypes CSN3; DGAT1; GH; PRL were used for the study. One-way analysis of variance was carried out using the Excel software application from the Microsoft Office package; according to which the influence of the polymorphism factor of the studied genes on the indicators of milk production of cows was determined.

Results

Studies have shown that the kappa-casein genotype had the greatest significant effect on the protein mass fraction in cow's milk; its proportion of influence in first-calf heifers was $\eta 2$= 0.353 (F= 40.323; P<0.001); in full-age cows was $\eta 2$= 0.140 (F= 13.400; P<0.001) (Table 1).

Table 1: *The proportion and significance of the influence of the kappa-casein genotype on the indicators of milk production of cows.*

№	Indicator	1st lactation			3rd lactation		
		η^2, %	$F_{factual}$	P	η^2, %	$F_{factual}$	P
1	Milk yield per lactation	0.013	0.993	0.373	0.020	1.661	0.193
2	Mass fraction of fat	0.030	2.294	0.104	0.015	1.285	0.280
3	Milk fat	0.019	1.456	0.236	0.025	2.086	0.127
4	Mass fraction of protein	0.353	40.323***	0.0001	0.140	13.400***	0.0001
5	Milk protein	0.074	5.882**	0.003	0.039	3.390*	0.036
Hereinafter: * - P<0.05, ** - P<0.01, *** - P<0.001							

Also; a significant influence of the kappa-casein genotype was revealed on the yield of milk protein in the 1st lactation that was $\eta 2$= 0.074 (F= 5.882; P<0.01) and $\eta 2$= 0.039 (F= 3.390; P<0.05). The influence of the kappa-casein gene did not exceed 0.030 and was not reliable in terms of other indicators of milk production. Consequently; a high power of the influence of the kappa-casein gene on protein content of milk of cows was revealed. A high and reliable effect was revealed in terms of the mass fraction of fat in milk in cows for the diacylglycerol O-acyltransferase gene for the 1st lactation that was $\eta 2$= 0.189 (F= 17.202; P<0.001); that was $\eta 2$= 0.109 (F= 10.101; P<0.001) for the 3rd lactation (table 2). And a significant influence was also found on the amount of milk fat in first-calf heifers $\eta 2$= 0.059 (F= 4.656; P<0.01).

Consequently; a high power of influence of the diacylglycerol O-acyltransferase gene on the fat content of milk of cows was revealed. It should be mentioned that although the indicator of the

milk yield per lactation was unreliable; it had a rather good value of the proportion of influence η2 = 0.032 and 0.026. It can signify about some influence of the gene of diacylglycerol O-acyltransferase on the level of milk yield in cows too. According to the somatotropin gene in experimental animals; a significant degree of genotype influence was revealed only by milk yield for the 3rd lactation η2= 0.057 (F= 4.949; P<0.01) (table 3). η2 was less than 0.028 and unreliable in terms of other indicators of milk production (Table 2).

Table 2: *The proportion and significance of the influence of the genotype of diacylglycerol O-acyltransferase on the indicators of milk production of cows.*

№	Indicator	1st lactation			3rd lactation		
		η^2, %	$F_{factual}$	P	η^2, %	$F_{factual}$	P
1	Milk yield per lactation	0.032	2.437	0.091	0.026	2.219	0.112
2	Mass fraction of fat	0.189	17.202***	0.0001	0.109	10.111***	0.0001
3	Milk fat	0.059	4.656**	0.011	0.005	0.383	0.682
4	Mass fraction of protein	0.003	0.203	0.817	0.012	1.033	0.358
5	Milk protein	0.026	1.991	0.140	0.005	0.455	0.635

Table 3: *The proportion and reliability of the influence of the somatotropin genotype on the indicators of milk production of cows.*

№	Indicator	1st lactation			3rd lactation		
		η^2, %	$F_{factual}$	P	η^2, %	$F_{factual}$	P
1	Milk yield per lactation	0.025	1.895	0.154	0.057	4.949**	0.008
2	Mass fraction of fat	0.028	2.095	0.127	0.004	0.340	0.712
3	Milk fat	0.021	1.566	0.212	0.001	0.114	0.892
4	Mass fraction of protein	0.005	0.338	0.714	0.001	0.100	0.905
5	Milk protein	0.027	2.077	0.129	0.002	0.154	0.857

Table 4: *The proportion and reliability of the influence of the prolactin genotype on the indicators of milk production of cows.*

№	Indicator	1st lactation			3rd lactation		
		η^2, %	$F_{factual}$	P	η^2, %	$F_{factual}$	P
1	Milk yield per lactation	0.018	1.327	0.268	0.014	1.130	0.325
2	Mass fraction of fat	0.012	0.914	0.403	0.044	3.822*	0.024
3	Milk fat	0.012	0.889	0.413	0.001	0.111	0.895
4	Mass fraction of protein	0.004	0.280	0.756	0.022	1.850	0.161
5	Milk protein	0.018	1.378	0.255	0.009	0.759	0.470

According to the prolactin gene; a significant proportion of the influence is observed in cows in the 3rd lactation in terms of the mass fraction of fat in milk η2= 0.044 (F= 3.822; P<0.05) (table 4). No significant and reliable influence was found in terms of other indicators (Table 3).

Thus; it was revealed that the kappa-casein gene had the greatest influence on the mass fraction of protein; diacylglycerol O-acyltransferase and prolactin on the mass fraction of fat; somatotropin on milk yield. An analysis of variance was also carried out for the influence of individual alleles of marker genes on the indicators of milk production of cows. It was found that allele A of the kappa-casein gene has a significant effect on the qualitative indicators of milk production of cows: milk fat η2= 0.035 (F= 4.727; P<0.05); the mass fraction of protein in milk η2= 0.036 (F= 4.879; P<0.05); milk protein η2= 0.032 (F= 4.365; P<0.05); provided that protein content of milk had the highest proportion of influence. Allele B of the kappa-casein gene has a significant effect only on the mass fraction of protein η2= 0.342 with a high value of Fisher's criterion that is Ffactual= 26.489 (P<0.001). This suggests that both the genotype and the allele of kappa-casein are closely related to the high protein content of milk of animals. Consequently; the protein content of milk of cows is 34-35% dependent on the kappa-casein gene and its allelic variant. The degree of influence of the desired B allele on other indicators of milk production was less than η2= 0.013 Allele A of the diacylglycerol O-acyltransferase gene had the greatest effect on the amount of milk fat that was η2= 0.058 (F= 7.949; P<0.01). It also had a significant effect on milk yield η2= 0.045 (F= 6.175; P<0.05) and the milkness index η2= 0.056 (F= 7.743; P<0.01); which was not observed for allele A of the kappa-casein gene. The desired allele K of the diacylglycerol O-acyltransferase gene had the greatest significant influence on the

fat mass fraction in the milk of first-calf heifers; its influence was $\eta 2 = 0.163$ ($F = 17.305$; $P<0.001$). Also; the significant influence of this allele was in terms of the mass fraction of protein in milk $\eta 2 = 0.061$ ($F = 5.739$; $P<0.05$) and according to the milkness index $\eta 2 = 0.051$ ($F = 4.794$; $P<0.05$). Consequently; it also will be possible to achieve an increase in protein content of milk with a targeted fat content of milk. The allele V of the somatotropin gene has a significant effect only on the yield of milk protein $\eta 2 = 0.097$ with the value of Fisher's criterion that is $F_{factual} = 3.641$ ($P<0.05$). For alleles A and B of the prolactin gene; no reliable and significant influences on the indicators of milk production of cows were revealed (Table 4).

Conclusion

The genotype and allele B of kappa-casein has the strongest and most reliable effect on protein content of milk; the genotype and allele K of diacylglycerol O-acyltransferase and also prolactin genotype on fat content of milk; Somatotropin genotype on the level of milk yield. At the same time; among the studied marker genes the CSN3 and DGAT1 genes have a wider influence on the indicators of milk production.

References

1. Abeldinov RB, Bekseitov TK. Biological status of cows of the Simmental breed of Kazakhstan selection with a different genotype for candidate genes for protein metabolism: Vestnik of the Altai State Agrarian University. 2017; 2: 81-87.
2. Zagidullin LR, Shaidullin RR, Akhmetov TM, Tyulkin SV. Polymorphism of genes of kappa-casein and diacylglycerol O-acyltransferase in black-and-white cattle. Dairy Vestnik. 2020; 1: 24-34.
3. Zinovieva NA, Kostyunina OV, Gladyr EA, Bannikov AD, Kharzinova VR, Larionova PV, et al. The role of DNA markers of production characters of agricultural animals. Animal Science. 2010; 1: 8-10.
4. Kapelnitskaya E, Shilova A, Kapelnitskaya E. Milk production and technological properties of milk of cows with different genotypes of kappa-casein. Chief zoo technician. 2015; 4: 34-39.
5. Zinnatova FF, Shakirov SK, Yulmetyeva YR. Influence of breed and genotype for genes CSN3, DGAT1, PRL, LGB on milk production of cattle. Vestnik of the Russian Academy of Agricultural Sciences. 2012; 5: 65-67.
6. Yulmetyeva YR, Zinnatova FF, Rachkova EN, Shamsieva LV, Shakirov SK. The influence of genetic aspects on the dynamics of milk production of Holstein cattle. Achievements of science and technology of the agro-industrial complex. 2015; 11: 99-101.
7. Shaidullin RR, Sharafutdinov GS, Moskvichyova AB, Ziganshin BG, Tyulkin SV. Interlinear polymorphism of the kappa-casein gene and its influence on milk production of cows. Achievements of science and tech: agro-industrial complex. 2019; 5: 51-55.
8. Thaller G, Kühn C, Winter A, Ewald G, Bellmann O, Wegner J, et al. DGAT1, a new positional and functional candidate gene for intramuscular fat deposition in cattle. Anim Genet. 2003; 34: 354-357.
9. Pozovnikova MV. Milk production of cows with different genotypes DGAT1. Effective animal breeding. 2018; 7: 46-47.
10. Pozovnikova MV, Serdyuk GN, Tulinova OV. Diacylglycerol acyltransferase-1 gene polymorphism in bulls of Russian Ayrshire breed gene pool: Vestnik of the Orenburg Agrarian University. 2018; 3: 295-297.
11. Winter A, Kramer W, Werner FAO, Kollers S, Kata S, Durstewitz G, t al. Association of a lysine232/alanine polymorphism in a bovine gene encoding acylCoA: diacylglycerol acyltransferase (DGAT1) with variation at a quantitative trait locus for milk fat content. PNAS. 2002; 14: 9300-9305.
12. Epishko OA, Peshko VV, Peshko NN. The use of genes LGB, PRL and GH as markers of milk production in the selection of cattle of the Belarusian black-and-white breed: Scientific notes. 2018; 54: 84-88.
13. Strapko KV, Epishko OA, Peshko VV, Peshko NN. Somatotropin (GH), prolactin (PRL) and beta-lactoglobulin (LGB) genes as molecular genetic markers of milk production in cattle. Collection of scientific articles of the XX International scientific-practical conference. Modern tech agricultural production. 2017; 151-153.
14. Alfonso E, Rojas R, Herrera JG, et al. Polymorphism of the prolactin gene (PRL) and its relationship with milk production in American Swiss cattle. African J Biotechnol. 2012; 11: 7338-7343.
15. Goryacheva TS, Goncharenko GM. Genetic variants of κ-casein and prolactin in relation to milk production of black-and-white cows. Agricultural Biol. 2010; 4: 51-54.
16. Pozovnikova MV, Serdyuk GN, Mitrofanova OV. Association of single nucleotide polymorphisms of candidate PRL and β-LG genes with economically useful characteristics in black-and-white cows. Genetics and animal breeding. 2017; 4: 31-36.
17. Nam IY, Zayakin VV, Drozdov EV. Allelic Polymorphism of the Somatotropin Gene among Holstein-Friesian Breed in the Livesock Farming in the Bryansk Region. World Applied Sciences J. 2014; 30: 802-805.
18. Heidari M, Azari MA, Hasani S, Khanahmadi A, Zerehdaran S. Effect of Polymorphic Variants of GH, Pit1, and βLG Genes on Milk Production of Holstein Cows. Russian J Genetics. 2012; 4: 417-421.