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ASSESSMENT OF PRODUCTIVITY AND QUALITY OF COW MILK DEPENDING ON THE KAPPA-CASEIN GENOTYPE AND THE HOUSING METHOD

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Increasing the nutritional value of dairy raw materials is one of the priority tasks of modern dairy cattle breeding. Therefore, today the assessment of factors forming the qualitative characteristics of milk is of particular relevance. The article presents the results of research on the determination of physicochemical indicators of cow milk quality depending on the kappa-casein genotype and the method of housing with its subsequent assessment by the qualimetric method. It was established that out of 76 experimental animals, the number of individuals with the kappa-casein genotypes AA, AB and BB was 48, 24 and 4 heads, respectively. In the tethered housing method, cows of the BB genotype (754.3 kg) had higher milk yields, animals with the AA (600.8 kg) and AB (587.9 kg) had lower yields. However, the milk of cows with the BB genotype contained more mass fractions of protein by 0.83 and 1.02 %, fat by 0.43 and 0.89 %, lactose by 1.14 and 1.19 %, dry matter by 3.44 and 3.48 %, and dry non-fat milk residue by 2.36 and 2.49 % compared to individuals with the AA and AB genotypes. In the case of free-range housing, on the contrary, 3.4 % more milk was obtained from cows with the AA genotype than from cows with the AB genotype, while the difference between them and cows with the BB genotype was noticeably greater by 18.5 %. In cows with the BB genotype, milk productivity was lower not only compared to animals with the AA genotype, but also compared to individuals with the AB genotype by 12.8 %. With this method of housing, the milk of cows with the BB genotype contained more protein by 0.58 and 0.38 %, fat by 0.19 and 0.03 %, lactose by 0.03 and 0.02 %, and dry matter by 0.24 and 0.05 %, respectively, compared to individuals with the AA and AB genotypes. According to the calculation of the qualimetric indicator of quality and safety, it was found that higher quality and more nutritious milk was obtained from cows with the kappa-casein genotypes AB and BB under the tethered method of keeping by 44.0 and 53.1% and by 2.7 and 0.6 % – under the untethered method, compared to animals with the AA genotype.

Keywords: kappa-casein, qualimetric assessment, cows, method of housing, milk quality.

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ОЦІНКА ПРОДУКТИВНОСТІ ТА ЯКОСТІ МОЛОКА КОРІВ ЗАЛЕЖНО ВІД ГЕНОТИПУ КАПА-КАЗЕЇНУ І СПОСОБІВ УТРИМАННЯ

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Підвищення харчової цінності молочної сировини є одним із пріоритетних завдань сучасного молочного скотарства. Тому на сьогодні особливої актуальності набуває оцінювання чинників формування якісних характеристик молока. У статті викладено результати досліджень щодо визначення фізико-хімічних показників якості молока корів залежно від генотипу капа-казеїну та способу утримання з подальшою його оцінкою кваліметричним методом. Установлено, що із 76 дослідних тварин кількість особин із генотипами капа-казеїну АА, АВ і ВВ становила відповідно 48, 24 і 4 голови. За прив'язного способу утримання вищими надоями характеризувалися корови генотипу ВВ (754,3 кг), меншими – тварини з генотипом АА (600,8 кг) і АВ (587,9 кг). Натомість, у молоці корів із генотипом ВВ містилося більше масових часток білка на 0,83 і 1,02 %, жиру – на 0,43 і 0,89 % і лактози – на 1,14 і 1,19 %, сухої речовини – на 3,44 і 3,48 % та сухого знежиреного залишку молока – на 2,36 і 2,49 % проти особин із генотипами АА та АВ. За безприв'язного утримання від корів із генотипом АА, навпаки, було одержано молока на 3,4 % більше, ніж від корів із генотипом АВ, у той час як відмінність між ними і коровами з генотипом ВВ була помітно більшою на 18,5 %. У корів із генотипом ВВ молочна продуктивність була нижчою не лише до тварин із генотипом АА, але й порівняно з особинами генотипу АВ на 12,8 %. За цього способу утримання молоко корів із генотипом ВВ містило більше білка на 0,58 і 0,38 %, жиру – на 0,19 і 0,03 %, лактози 0,03 і 0,02 % та сухої речовини – на 0,24 і 0,05 %, відповідно, порівняно з особинами з генотипами АА і АВ. За розрахунку кваліметричного показника якості та безпечності встановлено, що якісніше та поживніше молоко було отримано від корів із генотипами капа-казеїну АВ та ВВ за прив'язного способу утримання на 44,0 і 53,1 % та на 2,7 і 0,6 % – за безприв'язного, порівняно з тваринами із генотипом АА.

Ключові слова: капа-казеїн, кваліметрична оцінка, корови, спосіб утримання, якість молока.

Introduction. The problem of improving milk quality occupies a prominent place in the system of its rational production and use. In view of this, an important prognostic step has recently been made in deepening research into the protein composition of milk, in particular the casein content (Caroli A. M. et al., 2009; Lucey J. et al., 2017; Stocco G. et al., 2018), which is largely due to the development of more advanced and accurate

assessment methods (Bratunyak G. V. et. al., 2003; Semko T. V., 2015; DSTU 3662-2018).

It is well known that the kappa-casein genotype is closely related to the milk yield of cows (Smoliar V. I. et al., 2007; Erbe M. et al., 2012; Khaizaran Z. A. et al., 2014; Thomasen J. R. et al., 2014; Su G. et al., 2015; Plivachuk O. et al., 2015). However, the ambiguity of views on determining which of the AA, AB or BB genotypes is the best for obtaining high milk yields remains debatable. This is especially true for newly created domestic dairy breeds of cattle, the breeding of which in modern climatic conditions, in particular global warming, is significantly influenced by paratypic factors, including feeding, season of the year and conditions of detention (Zubets M. V. et al., 2002; Yefimenko M. et al., 2007; Prykhodko M. F., 2011; Chaharovskyi O. P. et al., 2013; Antoniuk T. A., 2017).

The method of housing plays an important role in shaping the quality of milk (Kirner L. et al., 2009). In some information sources (Oleshko N. P., 2011) it is emphasized that both tethered and free-range housing contribute to the disclosure of the genetic potential of animals to almost the same extent. In particular, in terms of mass fractions of fat in milk, cows that were kept free-range dominated animals in tethered housing, respectively by 0.08%, while in terms of the amount of milk fat, the existing difference shifted in favor of the latter by 3 kg, respectively. However, referring to the results of our own studies of the milk quality of cows that were bred in two ways of housing (Gieseke D. et al., 2022), a number of distinctive trends are outlined. In particular, the group of animals in free-range housing in terms of the content of mass fractions of dry matter, including fat, protein and lactose in milk was superior to cows kept on a leash. At the same time, the largest difference was observed in the summer period, and the smallest in the winter. In this sense, the work (O'Callaghan F. et al., 2016) is interesting, in which the authors note similar changes in the chemical composition of milk in tethered and untethered methods of housing cows. A thorough analysis of the publication indicates an increase in the mass fractions of fat and protein in animals kept on a leash by 0.12 and 0.05 %, respectively, with 100 % milk being classified as a higher grade, while in tethered conditions only 27.9 % of it met the requirements of this grade.

Other scientists note that animals in tethered housing are characterized by a slight (0.04 %) decrease in the mass fraction of fat in milk with a simultaneous increase in the mass fraction of protein – by 0.21 % and the amount of milk fat – by 17.5 %. In the development of these achievements (Bargo F., et al., 2002) also see free-range housing as a model for improving the quality of milk, compared with tethered housing. However, researchers note a slight decrease in the content of dry skimmed milk residue by 0.03 %, mass fractions of fat – by 0.03 % and protein – by 0.01 % in the milk of cows in tethered housing.

At the same time, the analysis of scientific sources of literature showed the lack of information on the comparative assessment of the quality of milk of cows of domestic breeds with different kappa-casein genotypes depending on the method of housing – tethered or untethered, which determined the relevance and practical significance of the work carried out.

Obtaining new data will contribute to the improvement of domestic herds of cows in the direction of increasing the technological properties of milk and consolidating the best hereditary traits associated with quality and milk protein content.

The purpose of the work is to assess the impact of methods of keeping cows with different kappa-casein genotypes on the quantitative and qualitative indicators of milk and its qualimetric assessment.

Materials and methods. The study was conducted in the production conditions

of the DH DH "Hontarivka" of the Livestock Farming Institute of NAAS of Ukraine, Chuguyiv district, Kharkiv region, on 76 animals, which were kept in two ways: untethered on walking and feeding grounds (spring-summer period) and on a leash (autumn-winter period) with the organization of year-round uniform feeding. Laboratory studies of milk samples were performed on modern laboratory equipment of the Testing Center of the IT NAAS. The research scheme included the selection of animals of the Ukrainian black-and-white dairy breed and their division into groups based on the results of DNA testing for the kappa-casein genotype, using the PCR-RFRP method (Ibatullin et al., 2017; Vlizlo V. V., 2012). Hair bulbs were used as biological material for genetic testing.

Milk productivity was recorded based on the results of individual monthly control milkings of cows with subsequent calculation for each month and for the entire lactation period (305 days). Milk samples taken during control milking were filtered through four layers of gauze, placed in sterile plastic bottles with lids, cooled in a refrigerator at a temperature of +4 – +6 ºC and delivered to the laboratory for further research. To prevent milk from turning sour, a preservative tablet "Mikrotabs II" was added to each bottle on the eve of control milking. All work on milk sampling was carried out in accordance with the requirements of DSTU ISO 707:2002 "Milk and dairy products. Guidelines for sampling".

In the average milk samples, the mass fractions (%) of fat, protein, lactose, dry matter were determined according to DSTU 8396:2015 «Cow's milk. Determination of the mass fraction of fat, protein, lactose, dry matter by infrared spectrometry (express method)»; the freezing point was investigated by the conductometric method according to DSTU 7671:2014 «Cow's milk. Determination of the freezing point by the conductometric method (express method)» on the Bentley milk analyzer (USA), the number of somatic cells in milk was determined by the fluorescence-optical laser flow cytometry (FCMA) method on the combined model device «Somacount 150» manufactured in the USA according to DSTU 7672:2014 «Cow's milk. Determination of the number of somatic cells by flow cytometry (express method)».

For the purpose of comprehensive assessment of the quality of milk of experimental cows, a qualimetric approach was used, which is based on the use of a set of physicochemical indicators expressed by quantitative criteria.

Research results. According to the results of DNA testing of the experimental livestock, it was found that it was represented by three kappa-casein genotypes: AA (63.1 %), AB (31.6 %), and BB (5.3 %) (Fig. 1)**.**

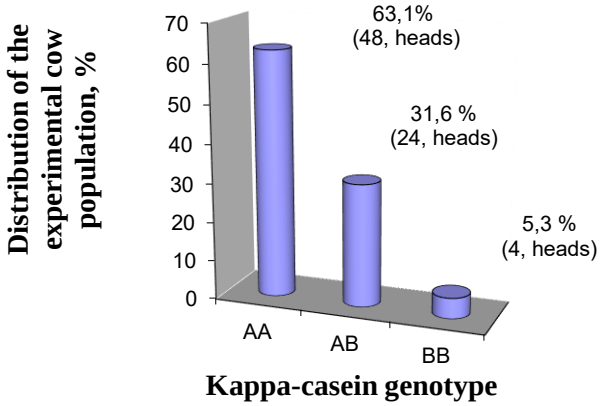

*Fig. 1***. Distribution of experimental cows by kappa-casein genotypes**.

The results obtained reflect the consequences of long-term breeding practices in the farm, aimed mainly at the use of fertile animals carrying the AA genotype, which is traditionally associated with increased milk yields. The established distribution of genotypes indicates the dominance of selection pressure towards increasing milk yields with insufficient attention to the formation of signs of technological properties of milk.

It was noted that the milk yields of cows differed depending on the kappa-casein genotype and conditions of housing (Fig. 2).

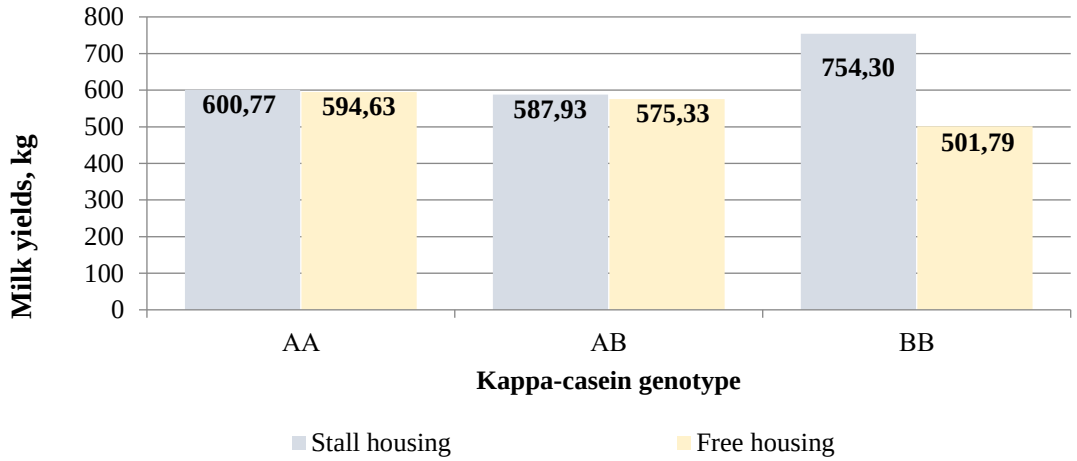

Fig. 2. **Milk yields of cows with different kappa-casein genotypes depending on the method of housing (on average for the period)**.

When housing in a tethered environment, the best indicators of milk productivity were demonstrated by animals with the BB genotype, which exceeded individuals with the AA genotype by 153.5 kg or 25.6 % ($p<0.01$) and AB by 166.4 kg or 28.2 %. When kept loose, the highest level of productivity was in cows with the AA genotype, animals of the AB genotype were close to them, while the minimum milk yields were characteristic of individuals with the BB genotype. In particular, cows with the AA genotype produced 19.3 kg or 3.4 % more milk than cows with the AB genotype, while the difference between them and cows with the BB genotype was noticeably greater by 92.8 kg or 18.5 % ($p<0.05$). In cows with the BB genotype, milk productivity was lower not only than in animals with the AA genotype, but also compared to individuals with the AB genotype by 73.5 kg or 12.8 % ($p<0.05$).

It was established that regardless of the method of housing cows with the BB kappa-casein genotype were characterized by a higher content of protein by mass fraction in milk, compared to animals of the AA and AB genotypes. When kept tied, their advantage was 0.83 % ($p<0.001$) and 1.02 % ($p<0.01$), respectively, while when kept loose - 0.58 % ($p<0.01$) and 0.38 % (Table 1).

A similar pattern was observed with respect to the mass fraction of fat in milk. In particular, the difference between them and animals with genotypes AA and AB was 0.43 % ($p<0.05$) and 0.89 % ($p<0.05$) respectively under tethered housing and 0.19 % ($p<0.05$) and 0.03 % under untethered housing.

Regarding the content of the mass fraction of lactose, cows with genotype BB under tethered housing significantly exceeded animals with genotypes AA and AB, respectively, by 1.14 % ($p<0.001$) and 1.19 % ($p<0.01$). At the same time, under untethered housing, the difference between groups in the mass fraction of milk sugar significantly decreased and leveled out to 0.03 and 0.02 %, without statistically significant differences. Similar trends were found when comparing the AB and AA genotypes: in the

case of tethered confinement, a slight decrease in the mass fraction of lactose by 0.0 5% was observed in the former, while in the case of untethered confinement, its increase by 0.01 % was observed, however, without a significant difference between the experimental groups in both cases.

Table 1

Cow's milk quality parameters under different housing of cow

Cows genotype at the kappa-casein locus	Mass fraction. %					Freezing point, minus °C
	Fat	Protein	Lactose	Dry matter	DNFR	
Stall housing						
AA	3,80±0,11	2,81±0,13	4,00±0,21	11,00±0,55	7,74±0,42	0,53±0,02
AB	3,34°°±0,23	2,62°°°±0,21	3,95°°°±0,28	10,96°°°±0,75	7,61°°±0,55	0,50°°±0,03
BB	4,23**±0,18	3,64**±0,02	5,14**±0,04	14,44**±0,08	10,10**±0,41	0,55**±0,00
Free housing						
AA	3,79±0,07	3,09±0,05	4,86±0,01	12,72±0,06	8,93±0,06	0,55±0,00
AB	3,95±0,07	3,29°±0,16	4,87±0,04	12,91±0,11	8,99±0,10	0,55°±0,00
BB	3,98*±0,03	3,67**±0,04	4,89±0,02	12,96*±0,09	8,98±0,07	0,56*±0,00

*Note. *p<0.05; **p<0.001 – the probability of the difference was calculated for cows with the AA genotype; °p<0.05; °°p<0.01; °°°p<0.001 – the probability of the difference was calculated for cows with the AB genotype.*

Under conditions of tethered housing, cows with the BB genotype also showed a more intensive increase in the mass fraction of dry matter in milk, compared to animals of the AA and AB genotypes. While the milk indicators of cows of the AB and BB genotypes were generally close, the established statistically significant advantage of animals of the BB genotype over their AA and AB counterparts, which was 3.44 % (p<0.001) and 3.48 % (p<0.01), respectively, gives reason to believe that it has a higher level of nutritional value. Under the non-tethered method of housing, cows of the BB genotype also showed an increase in the mass fraction of dry matter by 0.24 % (p<0.05), compared to the AA genotype and by 0.05 % relative to the AB genotype, but without a statistically significant difference between them.

The difference between the experimental groups of cows under tethered housing in terms of the mass fraction of dry non-fat residue in the structure of milk dry matter was smaller between the BB and AA genotypes and amounted to 2.36 % (p<0.01). While the difference between milk samples of animals with the BB genotype and individuals with the AB genotype was greater (2.49 %), but the level of statistical significance between these groups was lower (p<0.05). Under tethered housing, the mass fraction of dry non-fat residue in milk of cows with different kappa-casein genotypes was characterized by minimal variability and ranged from 8.93 % to 8.99 %.

The freezing point of natural milk did not have any significant and significant differences between groups of cows with different kappa-casein genotypes and depending on the methods of their housing, since the cryoscopic point was within the reference values: from minus 0.500 °C to minus 0.560 °C.

Given the growing attention to the safety and sanitary quality of milk as a human

food product, the level of somatic cells in milk was analyzed in experimental cows (Fig. 3).

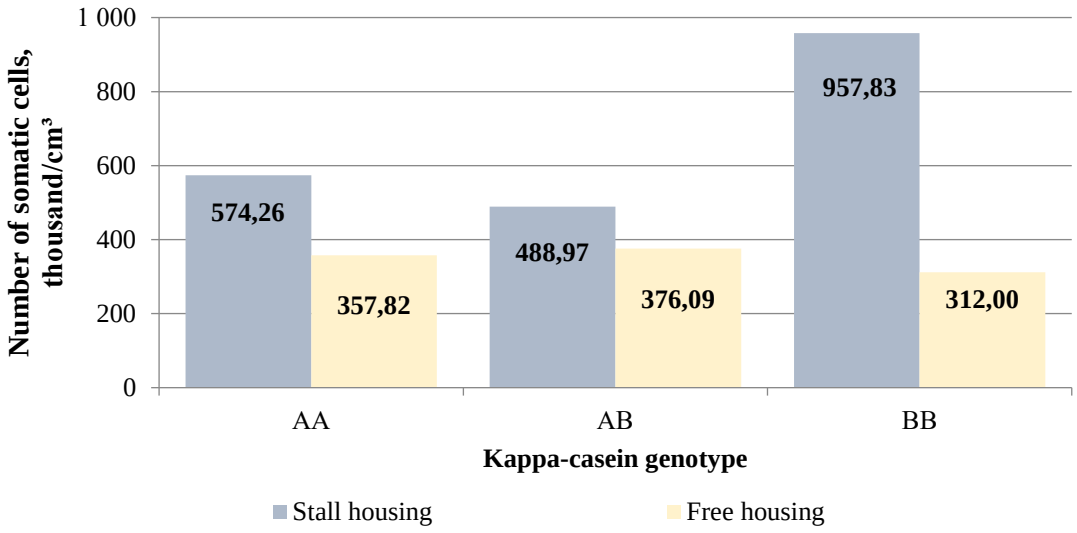

Fig. 3. **Dependence of the number of somatic cells in the cow's milk with different kappa-casein genotypes on the methods of housing (on average for the period)**

It was found that in animals with the BB genotype, when kept in a tethered manner, this indicator was significantly higher than in cows of the AA and AB genotypes, respectively, by 383.6 and 468.9 thousand/cm³ or 1.7 and 2.0 times ($p<0.001$). However, when untethered housing, the opposite trend was observed - its decrease by 45.8 and 64.1 thousand/cm³ or 12.8 and 17.0 % ($p<0.05$). Against the background of the detected differences in milk quality in cows with the BB genotype, a significant increase in the content of somatic cells was also found in the milk of animals with the AA genotype relative to animals with the AB genotype by 82.3 thousand/cm³ or 17.4 % ($p<0.05$) under tethered conditions. With untied housing, this difference decreased to 18.3 thousand/cm³ or 4.9 %.

Modern approaches to ensuring the safety and quality of dairy products require scientifically based determination and prediction of the corresponding indicators using qualimetric assessment methods. In this context, based on the analysis of the physicochemical characteristics of milk, an approach was developed for the statistical unification of individual parameters by reducing them to a uniform form, which made it possible to further integrate heterogeneous indicators into a complex qualitative characteristic of milk. For each of the studied parameters, the base value (Table 2) was taken as a standard corresponding to the maximum level of the qualitative characteristic and was used as a basis for comparative assessment.

Table 2

Basic indicators of cow's milk quality

Quality indicators	Fat, %	Protein, %	Lactose, %	Dry matter, %	DNFR, %	Freezing point, minus ºC	Somatic cells, thousand/cm³
Norm	3,40	3,00	5,00	11,50	8,50	0,520	500,00

At the first stage of the work, dimensionless (relative) values of unit indicators

were obtained by calculating the ratios of absolute values of laboratory measurements to the base values.

Then, given that the studied indicators were not the same in nutritional value, the weight coefficients of both group and individual parameters were justified by expert assessment of the data. The determination of weight coefficients within the group and individual parameters was performed provided that the sum of all their values is equal to one. For group indicators of milk K_A, the weight coefficients were 0.50, K_B – 0.20, K_C – 0.30. In turn, the weight coefficient of the nutritional value of milk (K_A) consisted of the weight coefficients of the mass fraction of fat (K_{A1}) and protein K_{A2}) to which the experts gave the highest values of 0.30 each. While lactose (K_{A3}) was characterized by an intermediate weight coefficient of 0.20, and the weight coefficients of the mass fractions of dry matter (K_{A4}) and dry non-fat residue (K_{A5}) were 0.10 each. The weight coefficients of single parameters characterizing both physical properties (K_B) and sanitary and hygienic features of milk (K_C) were equal to one, since each of them was represented by only one component.

The integral qualimetric indicator of the quality and safety of cow's milk was determined by the formula:

$$K = \sum_{n=1}^{5}(K_{An} \times q_{An}) + (K_{B1} \times q_{B1}) + (K_{C1} \times q_{C1}),$$

where K – integral indicator of cow's milk quality; K_{An} – weighting factors of chemical composition indicators (0,50); K_{B1} – weighting factor of physical properties (0,20); K_{C1} – coefficient of importance of sanitary and hygienic features (0,30); q_{An}; q_{B1}; q_{C1} – dimensionless values of unit parameters.

An example of calculating the integral indicator of milk quality and safety of cows with the AA genotype is given in Table 3.

Table 3

Calculation of the integral indicator of cow's milk quality and safety

Milk quality parameters	**Parameter designation**	**Weighting coefficients**	**Test samples (genotype AA)**	**Base samples**
Chemical composition:	K_A	**0,50**		
mass fraction in milk:				
fat	K_{A1}	0,3	0,309	0,3
protein	K_{A2}	0,3	0,235	0,3
lactose	K_{A3}	0,2	0,151	0,2
dry matter	K_{A4}	0,1	0,225	0,1
dry non-fat residue	K_{A5}	0,1	0,167	0,1
Total by group K_A	K_A	1	0,544	0,5
Physical properties:	K_B	**0,2**		
freezing point of milk	K_{B1}	1,0	1,064	1,0
Total by group K_B	K_B	1,0	0,213	0,2
Sanitary and hygienic features	K_C	**0,3**		
somatic cell content	K_{C1}	1,0	0,826	1,0
Total by group K_C	K_C	1,0	0,248	0,3
Integral quality indicator	K		1,005	1,0

The obtained value is an integral indicator of the conditional standard of quality and safety of milk, in addition to bringing different units of each measured indicator to a single format, as a result of such a conversion, it converts quantitative characteristics into a qualitative characteristic of milk, which can be represented as a value in percentage of the conditional standard of quality (100 %). Changes in the integral indicator under the influence of the method of housing and genotype of animals are given in Table 4.

Table 4

Integral qualimetric indicator of cow's milk quality of different genotypes under different housing, %

Cow's genotype at the kappa-casein locus	Stall housing	Free housing
AA	85,4	95,8
AB	129,4	98,5
BB	138,5	96,4

According to the results of qualimetric evaluation, the superiority of milk obtained from cows with the AB and BB kappa-casein genotypes in terms of its nutritional and technological value was established. The most pronounced effect was established with the tethered method of housing, where the integral indicator of milk quality of animals of these genotypes exceeded the corresponding values in cows of the AA genotype by 44.0 and 53.1 %, respectively. With untethered housing, this difference was preserved, but it was much less pronounced and amounted to 2.7 and 0.6 %, respectively.

Discussion. Analysis of the amplification results showed a clear dominance among the studied livestock of animals with the homozygous AA kappa-casein genotype, the number of which was 48 animals. This distribution of genotypes is probably the result of long-term selective selection, focused mainly on the targeted use in the farm of breeding animals associated with a high level of milk productivity, which is characteristic of carriers of the AA genotype (Prykhodko M. F. et al., 2009). Among the studied animals, 24 animals were represented by the heterozygous AB genotype, while the homozygous BB genotype, which is considered the most valuable in terms of the technological properties of milk and its suitability for cheese production, was detected only in 4 cows. The obtained data indicate a trend towards a decrease in the frequency of desired homozygous combinations with a simultaneous increase in the proportion of heterozygous animals, which may be a consequence of combined selection for high milk yields with the desire to preserve the appropriate technological characteristics of milk, which are consistent with the results of the studies (Ladyka L. M. et al., 2017).

In tethered housing, the best indicators of milk productivity were demonstrated by animals with the BB genotype, which exceeded in this indicator individuals with the AA genotype by 153.5 kg or 25.6 % and AB by 166.4 kg or 28.2 %. In untethered housing, the highest level of productivity was in cows with the AA genotype, animals of the AB genotype were close to them, while the minimum milk yields are inherent in individuals with the BB genotype. In particular, cows with the AA genotype produced 19.3 kg or 3.4 % more milk than cows with the AB genotype, while the difference between them and cows with the BB genotype was significantly greater at 92.8 kg or 18.5 %. In cows with the BB genotype, milk productivity was lower not only compared to animals with the AA genotype, but also compared to individuals with the AB genotype by 73.5 kg or 14.7 %.

The results obtained by us regarding the content of the main components of milk are fully consistent with the data of studies (O'Callaghan F. et al., 2016; Gulati A. et al., 2018), which indicate an ambiguous dependence of the chemical composition of milk on

the conditions of animal housing. In particular, cows with the BB genotype, both in tethered and untethered housing, were characterized by an increased content of fat and protein in milk. At the same time, the advantage of animals of this genotype in terms of mass fractions of lactose, dry matter and dry non-fat residue was more pronounced in the tethered housing.

The dependence between the values of the freezing point of milk of cows with different kappa-casein genotypes and the methods of their housing was not established in the conducted experiment, since the fluctuations of its values were within the reference limits. A lower content of somatic cells in the milk of cows was found in the untethered housing. During tethered housing, a significant increase in the content of somatic cells in milk was observed, and it was most pronounced in cows with the BB genotype.

Qualimetric analysis showed that the milk of cows carrying the AB and BB kappa-casein genotypes was characterized by a higher level of nutritional and technological suitability for processing, compared with products obtained from animals of the AA genotype. The greatest severity of intergroup differences was observed during tethered housing, where the integral indicator of milk quality in cows of the AB and BB genotypes was higher by 44.0 and 53.1 %, respectively. During untethered housing, the level of its manifestation significantly decreased to 2.7 and 0.6 %, respectively.

Thus, the generalization of the obtained results indicates that the nutritional value and individual quality characteristics of milk from cows with different kappa-casein genotypes are significantly determined by the conditions of their housing, which should be taken into account during its further processing. Animals with the AA genotype are characterized by relatively better stability of productive indicators in relation to changes in the method of housing, responding mainly by increasing milk yields. In contrast, cows with the AB and BB kappa-casein genotypes produce milk with a more balanced ratio of the main components and higher technological properties, which determines its better quality.

Conclusions.

1. The peculiarities of the formation of milk productivity and milk quality of cows of the Ukrainian black-and-white dairy breed with different kappa-casein genotypes under the influence of the method of keeping were revealed.

2. It was found that in the studied population the largest proportion was made up of animals with the AA genotype at the kappa-casein locus (63.1 %), while the AB and BB genotypes were less common, 31.6 and 5.3 %, respectively.

3. It was established that under conditions of tethered housing, the highest level of productivity was demonstrated by animals with the BB genotype, which exceeded in this indicator individuals with the AA genotype by 153.5 kg or 25.6 % ($p<0.01$) and AB - by 166.4 kg or 28.2 %. Their milk also contained more mass fractions of protein by 0.83 % ($p<0.001$) and 1.02 % ($p<0.01$), fat by 0.43 % ($p<0.05$) and 0.89 % ($p<0.05$), lactose by 1.14 % ($p<0.001$) and 1.19 % ($p<0.01$), dry matter by 3.44 % ($p<0.001$) and 3.48 % ($p<0.01$), and dry non-fat milk residue by 2.36 % ($p<0.01$) and 2.49 %.

4. In the free-range method of housing, the most milk was obtained from cows with the AA genotype, which is 19.3 kg or 3.4 % more compared to animals with the AB genotype and 92.8 kg or 18.5 % ($p<0.05$) compared to the BB genotype. While the milk of animals with the BB genotype was more enriched in mass fractions of protein by 0.58 % ($p<0.01$) and 0.38 %, fat by 0.19 % ($p<0.05$) and 0.03 %, lactose by 0.03 and 0.02 % and dry matter by 0.24 % ($p<0.05$) and 0.05 % than that of individuals with the AA and AB genotypes.

5. Qualimetric evaluation proved that milk from cows with genotypes AB and BB at the kappa-casein locus was characterized by higher quality and nutritional value

indicators compared to genotype AA. The most pronounced advantage was observed in tethered housing, where the integral quality and safety indicator was higher by 44.0 and 53.1 %, respectively, while in the untethered method this difference was only 2.7 and 0.6 %.

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