

## THE GENEALOGICAL STRUCTURE AND GENETIC SPECIFICITY OF THE ABORIGINAL UKRAINIAN WHITE-HEADED BREED

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### Abstract

The article deals with analysis of the genealogical structure of the aboriginal Ukrainian White-headed breed and the prospects of conservation of gene pool with a glance on inbred depression prevention. The genetic specific of the breed is detected. The genetic resources of the Ukrainian White-headed breed are preserved *ex situ* and *in situ*. There are preserve *in situ* Only 300 dairy cows belonging to 5 lines in the herd of Ukraine are preserved *in situ*. The genealogical and genetic structure of the Ukrainian White-headed breed herd is analysed with the use of materials of primary zootechnic account in a herd, annual catalogue of bulls, used for reproduction of cows in Ukraine. The set coefficient of inbreeding in population and polymorphism of genes of kappa-casein (k-Cn), beta-lactoglobulin ( $\beta$ LG), growth hormone (GH) were estimated using PCR-RFLP method. The analysis of polymorphism showed high level of homozygosity of the two investigated genes. The amount of homozygotes on the genes of k-Cn and GH exceeded significantly ( $P < 0.01$ ) the amount of heterozygotes as compared to the expected splitting. The level of homozygotic genotypes on three genes simultaneously made 27%. The results of retrospective analysis of the immunogenotypic testing of the Ukrainian White-headed breed animals of black and red colour are presented on the antigens of blood types. The population immunogenetic structure Ukrainian White-headed breed black and red colour local groups is analysed on the antigens of blood types. Distinctions of antigens frequencies are set in the systems of B, C, F, S. Specific for the breed are 4 alleles BGIOTG'B''G'', BGTG'P'B''G'', I<sub>1</sub> Q', QB'G' systems B blood types.

**Keywords:** aboriginal breed, inbreeding, gene pool, genetic specific, Ukrainian White-headed breed

### Introduction

The Ukrainian White-headed breed is bred out in the end of XIX century on the basis of the local Polesye cattle by the method of the reproductive crossing with the bulls of the Dutch breed from Groningen (Lucy et al., 1993). Two colours, red and black are characteristic for the breed. Animals have white spots on a head, stomach, extremities and tag of tail; in most cases round eye orbits there are "glasses". Considerable genetic specificity of local groups of the Ukrainian White-headed breed of different colours (Birukova, 2016).

The Ukrainian White-headed cattle of red colour till 1986 are conducted on Polesye (mainly in the Kyiv area farms). In the 60s of XX of century this breed was one of the breeds important for planned economy and ranked fourth in Ukraine (520000-660000 head) (Kravchenko, 1970). The basic population was concentrated in the pedigree farm "Antoninskiy" of Khmelnytsk region. To date this pedigree farm (Ltd "Podolskiy gospodar",

further Ltd "PG") has the only saved herd of the Ukrainian White-headed breed. According to the classification offered by I.V. Guzev (Zubets et al., 2007), the Ukrainian White-headed breed is attributed to the first category of domestic gene pool objects, being on verge of disappearance.

## Materials and methods

Materials of primary zootechnic account of Ltd "PG" are used for research. Materials of annual bulls catalogue were used for reproduction of cows in Ukraine (Eysner et al., 1972). For determination of coefficient of inbreeding ( $F_x$ ) the S. Wright methods in D. A. Kislovskiy modification were applied (Ernst et al., 1994). Polymorphism of genes of kappa-casein (k-Cn), beta-lactoglobulin (BLG), growth hormone (GH) were estimated through PCR-RFLP (polymerase chain reaction and restriction fragment length polymorphism) method on the standards of blood from the cows of the Ukrainian White-headed breed of Ltd "PG" (n=74). For a selection to DNA drew on the standard sets of "DNA-sorb B" ("Ampliens", Moscow, Russia). For amplification of fragments of the investigated genes the following primers were used: CSN3 (5' GAAATCCCTACCATCAATACC-3' and 5'CCATCTACCTAGTTTAGATG-3') (Pinder et al., 1991); BLG (5'GTGCTGGACACCGACTACAAAAAG-3' and 5'GCTCCCGGTATATGACCACCCTCT-3' (Medrano et al., 1990); GH (5'GCTGCTCCTGAGGGCCCTTC-3' and 5'GCGGCGGCACTTCATGACCC-3') (Lucy et al., 1993). For the analysis of CSN3, BLG, GH genes polymorphism restrictases, selected for each gene (Hind III, Hae III, AluI, respectively) were used. The concentration of DNA was checked up by electrophoresis in 2% agarose gel. The analysis of materials of the immunogenetic testing of animals of the Ukrainian White-headed breed is conducted on the antigens of blood types: to the black colour is a pedigree farm "Antoninskiy" (224 animals), to the red colour is a collective farm the name of Lenin of the Kyiv area (390 animals), bulls-producers of breeding enterprise Ukraine (Kruglyak et al., 1987). The statistical evaluation of the data was done applying the methods of M. A. Plokhinskiy (Plokhinskiy, 1961).

## Results and discussion

To date the genetic resources of the Ukrainian White-headed breed, preserved *in situ*, are concentrated in Ltd "PG" (1012 animals on 01.01.2017). There are 300 milk cows in the herd. The average yield of milk of first calf cows for 305 days is 4098 kg, the fat content – 3.61%; during the second lactation the yield is 4124 kg, fat content -3.61% and during the third lactation the milk yield is 4317 kg while the fat content is 3.64%. The animals of this breed form 0.2% of all dairy cattle in Ukraine. The genetic resources of the Ukrainian White-headed breed, preserved *ex situ*, are concentrated in the Ltd "Khmelnysk head enterprise in pedigree business in animal breeding" (Ltd "KHEPBAB") and the Bank of Animal Genetic Resources of the Institute of Animal Breeding and Genetics behalf M.V.Zubtsya National academy of agrarian sciences of Ukraine (BAGR IABG).

To date in BAGR IABG and Ltd "KHEPBAB" semen (37692 doses) of 11 thoroughbred bulls of the Ukrainian White-headed breed and 2 crossbred (Ukrainian White-headed breed - 50%, Holstein breed - 25%, Groningen breed - 25%). Also, 30 embryos, got from 5 pairs of animals of the Ukrainian White-headed breed are saved in BAGR IABG (Kovtun et al., 2015).

The cows of the Ukrainian White-headed breed are characterized by long productive life and 8-14 lactations. For example, the daughter of bull Orel 235 (line of Ozone 417) Soika

UA6800085683, born in 2004, on the average for 9 lactations gave 6164 kg milk, with fat content – 3.67% (226 kg). The highest lactation for this cow - sixth (7285 kg – 3.7% are 270 kg). The daughter of bull Yak 667 (lines of Ozone 417) Lilia UA6800155591, born in 1999, on the average for 12 lactations gave 5221 kg milk, with fat content – 3.64% (190 kg). Productivity for a highest (11) lactation was 7022 kg of milk, with fat content 3.73%. The presented cows continue productive life in a herd. The mentioned traits talk not only about genetic potential of the productivity, but also about the resistance and adaptability of these animals.

The genealogical structure of the herd for the period 2015-2017 is presented by five lines of the Ukrainian White-headed breed (Table 1). The most numerous is the posterity of the bulls of the line of Ozone 417. Less number of cows belongs to the lines Rezviy 33 and Mart 171. Bull Ermitage 1328 belongs to the line of Fikus 491, which is the continuer of line of Zhargun 33. Only nine cows are attributed to the line of Zhargun 157. Cows of this line in posterity of bull Neapol 561 have the productivity below the average for the investigated sample.

Table 1. Description of Ukrainian White-headed breed bulls

| Bull                 | Years of use | Productivity of daughters |             |                          |                          |
|----------------------|--------------|---------------------------|-------------|--------------------------|--------------------------|
|                      |              | n daughters               | n lactation | yield during 305 day, kg | concentration of fat , % |
| Lines of Ozone 417   |              |                           |             |                          |                          |
| Som 6800085660       | 2008-2011    | 205                       | 3.1±0.1     | 4229±54                  | 3.63±0.01                |
| Orel 235             | 2002-2010    | 63                        | 4.6±0.3     | 4546±115                 | 3.62±0.01                |
| Plus 629             | 2001-2012    | 65                        | 4.0±0.3     | 4225±104                 | 3.62±0.01                |
| Los 987              | 2011         | 2                         | 1.5±0.5     | 4457±11                  | 3.64±0.03                |
| Yak 667              | 1998, 2009   | 4                         | 5.5±2.5     | 4620±262                 | 3.64±0.01                |
| Lupin 335            | 2002         | 2                         | 6.0±0.0     | 4205±16                  | 3.59±0.03                |
| Lines of Rezviy 33   |              |                           |             |                          |                          |
| Zlak 673             | 2005-2013    | 41                        | 1.3±0.1     | 4282±138                 | 3.59±0.01                |
| Chardash 55          | 2005         | 9                         | 6.0±0.5     | 4901±434                 | 3.63±0.01                |
| Prince 445           | 2001-2006    | 5                         | 6.8±0.7     | 5342±609                 | 3.63±0.03                |
| Signal 721           | 2000-2004    | 9                         | 6.4±0.8     | 4390±281                 | 3.62±0.03                |
| Lines of Fikus 491   |              |                           |             |                          |                          |
| Ermitage 1328        | 2001-2003    | 8                         | 7.6±0.5     | 4685±298                 | 3.62±0.02                |
| Lines of Mart 171    |              |                           |             |                          |                          |
| Nikel 6800410641     | 2011-2014    | 56                        | 1.3±0.3     | 4054±107                 | 3.58±0.01                |
| Chubok 221           | 2004         | 13                        | 5.6±0.3     | 4519±225                 | 3.63±0.01                |
| Tsokol 6800410646    | 2012         | 10                        | 1.1±0.1     | 4276±143                 | 3.58±0.02                |
| Lines of Zhargun 157 |              |                           |             |                          |                          |
| Okun 6787            | 2006, 2011   | 6                         | 5.7±0.3     | 4283±348                 | 3.55±0.05                |
| Neapol 561           | 2011         | 3                         | 1.7±0.3     | 3287±325                 | 3.67±0.02                |

The highest productivity was shown by the daughters of Prince 455 and Chardash 55 (line of Rezviy 33), Ermitage 1328 (lines of Fikus 491) and Yak 667 (lines of Ozone 417). The

Ermitage 1328 daughters showed the highest average number of lactations. On this index it should be noted cows of line of Rezviy 33, which are daughters of Chardash 55, Prince 445, Signal 721. Bulls which are recently used in a herd are characterized appropriately by the subzero amount of lactations for daughters. At posterity of Zlak 673 there is a tendency to the of short duration productive life.

In the herd of Ltd "PG" two cows are daughters of bull Solovey 6568 the Ukrainian Black-and-Whight dairy breed (lines of Valiant 1650414). These animals are on the ninth lactation, the average productivity is  $4067 \pm 767$  kg of milk, fat content in milk -  $3.60 \pm 0.04\%$ .

To part the population was used Groningen breed bull I. Maindert 473266455. From nine daughters of this bull during 305 days of the first lactation  $4109 \pm 284$  kg of milk are obtained, having fat content  $3.53 \pm 0.02\%$ . From a crossbred (Holstein breed - 50%, Groningen breed - 50%) bull B. Barri 420306784 is got two youths of crossbred (Ukrainian White-headed breed - 50%, Holstein breed - 25%, Groningen breed - 25%) bulls. These bulls are being used in a herd now.

Ukrainian White-headed - a local breed has been improved by the intrabreed breeding for a long time. Lines of Ozone, Zhargun, Rezviy were created in the 40s of past century (Kravchenko, 1970). The founders of the lines of Rezviy and Ozone were used in the herd of pedigree farm "Antoninskiy" in 40-50s. Many bulls were used for a long period of time, for example Zlak 673 (lines of Rezviy). Obviously, that monitoring of the level of inbreeding in this breed is actual.

It should be noted that to have the bulls of the Ukrainian White-headed breed inbreeding of different degrees was frequently used. For example, the Ermitage 1328 was got with the use of "incest" ( $F_x = 12,5\%$ , II - II on Fikus 491); Orel 235 ( $F_x = 12,5\%$ , II - II on Rant 901); Chubok 221 - intimate inbreeding (II - III on Mart 171); Chardash 55 - moderate inbreeding (III - III on Mart 171).

In general, in the Ukrainian White-headed breed, there is a moderate level of inbreeding ( $1.6 \pm 0.13\%$ ). The degree of inbreeding among the cows was within the range of  $2.1 \pm 0.2\%$ . Most of the cows (96%) are purebred. At the same time in the herd there are cows with high degree of inbreeding. For example, the daughter of Orel 235 Nochka UA 6800085833 ( $F_x = 15,63\%$ , complex inbreeding) has the average productivity for 10 lactations 4504 kg of milk, with fat content – 3.68%. In posterity of bull of Som 6800085660 a few cows are got by "incest" ( $F_x = 25\%$ ). Among heifers and bulls also there is a moderate level of inbreeding ( $1.1 \pm 0.15\%$  and  $1.1 \pm 0.12\%$ , accordingly). It should be noted that the number of crossbred young animals increase. Only 64% of the calves are purebred.

The Ukrainian White-headed population genetic structure (table 2) was determined. The analysis of polymorphism showed the high level of homozygosity of two investigated genes. Amount homozygote on the genes of k-Cn and GH for significant ( $P < 0.01$ ) exceeded the amount of heterozygotes as compared to the expected splitting.

Table 2. The Ukrainian White-headed breed population genetic structure

|                    | Genes                               |                        |                                    |
|--------------------|-------------------------------------|------------------------|------------------------------------|
|                    | k-Cn                                | $\beta$ LG             | GH                                 |
| Genotype frequency | AA – 0.69<br>AB – 0.24<br>BB – 0.07 | AB – 0.46<br>BB – 0.54 | LL – 0.36<br>LV – 0.34<br>VV – 0.3 |
| Alleles frequency  | A – 0.81<br>B – 0.19                | A – 0.23<br>B – 0.77   | L – 0.53<br>V – 0.47               |

The level of homozygotic genotypes of the three genes made 27%. When comparing the population genetic structure of the genes of k-Cn, GH with data of other scientists (Kopylova and Glazko, 2005) reliable changes were not observed. However for the gene  $\beta$ LG in the population genetic structure significant changes ( $P < 0.05$ ) happened as a result of the increase of the allele B frequency, accordingly the level of homozygosity significantly diminished ( $P < 0.05$ ).

Considerable genetic specificity of the Ukrainian White-headed breed local groups of different colours (red and black) was established on the antigens of blood (Birukova, 2016). Ukrainian White-headed breed animals of both colours characterized by a general feature – have not high frequency (less than 0.15) of antigens B', D', I', O'. Between different local groups substantial distinctions are noticeable on antigens O (0,12 against 0,54), Y (0,51 against 0,21), I<sub>1</sub> (0,40 against 0,19). These differences testify for certain divergence of their gene pools. The analysis of herds of cattle by system of F from the point of view of their balanced in obedience to the model of Hardy-Weinberg showed that one 3 factors of forming of their structure there are features of genotypes of the used bulls. A presence of F<sup>v</sup> allele is characteristic for most bulls, used in the herd "Antoninskiy". Determination and maintenance of specificity of aboriginal breeds are actual, as there is the permanent narrowing of gene pool and loss of valuable gene complexes. For example, to date the gene pool of the local group Ukrainian White-headed breed of red colour is completely lost.

Four alleles BGIOTG'B''G'', BGTG'P'B''G'', I<sub>1</sub> Q', QB'G' are determined to be characteristic for the breed. Bulls with these alleles are attributed to the producers of desirable genotypes, the use of which in a herd at selection with the cows of corresponding genotypes, will provide high probability of obtaining animals with alleles specific for the breed. Such principle was used to obtain embryos from the animals of the Ukrainian White-headed breed and to preserve them in BAGR IABG. Such kind of selection of paternal pair at the level of herd is provided by a satiation and maintenance of biological variety the desirable inherited material at the level of kind.

## Conclusions

The genetic resources of the Ukrainian White-headed breed are preserved *ex situ* and *in situ*. The Ukrainian White-headed breed herd genealogical structure is presented by five lines (half as much, than 30 years back). Most numerous is the posterity of bulls of line Ozone 417. Specific for the breed are 4 alleles BGIOTG'B''G'', BGTG'P'B''G'', I<sub>1</sub> Q', QB'G' systems B blood types. Use of bulls of desirable genotypes on a herd at a selection with the cows of corresponding genotypes, will provide high probability to obtain animals with specific alleles for a breed. Ascertainment of the high level of homozygosity on two investigated genes.

Amount homozygote on the genes of k-Cn and GH for significant ( $P < 0.01$ ) exceeded the amount of heterozygotes as compared to the expected splitting. The level of homozygotic genotypes of three genes made 27%. The decline of Ukrainian White-headed cattle population effective size dictates the necessity of introduction of new approaches for maintenance of gene pool of local breed.

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