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SELECTION ADAPTED TO LOCAL CONDITIONS HAS THE POSSIBILITY TO IMPROVE THE ECONOMY OF SMALL DAIRY CATTLE POPULATIONS

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Abstract: Conventional breeding programs based on breeding objectives which cannot be achieved in small populations, especially in restrictive rearing conditions. Such populations will become less competitive and consequently their long-term existence will be endangered. However, it is possible to implement an alternative breeding program that will provide long-term competitive production by exploiting special qualities into specific conditions. In the case of the Slovenian Brown Swiss dairy cattle would be rational to implement a selection like is a fixation of desired alleles for beta and kappa casein together with longevity, fertility and milk yield achieved in an average rearing conditions. In the sample of 40 animals from a Slovenian Brown Swiss population there were determined 73.75% of desired allele B for kappa casein, as well as 75.5% of A2 allele for beta casein. According to the Hardy-Weinberg equilibrium it was concluded that sampled animals are representatives of the population. More than 40% of them has desirable genotypes for both, kappa and beta caseins. Besides desirable genotypes for both studied caseins, ten studied animals have one standard deviation higher direct genomic values (DGV) for production index as well as for total merit index compared to the population average. The proposed selection strategy will enable breeders in restricted rearing conditions to achieve a higher long-term competitiveness in milk production and processing. The national socio-economic effect of such an approach would be expressed in a higher value of cattle population, populated rural areas, preserved cultural landscape, higher touristic potential and higher employment.

Keywords: beta casein, genomics selection, kappa casein, niche production, special quality

Introduction

Breeding goals for dairy cattle, which are a main part of breeding programs, aimed toward the high production (Boichard and Brochard, 2012; Berry, 2014), assuming top farm management. An important part of the management represents the diet. The feed ratio for high production contains forages of excellent quality and a high proportion of cereals, proteins and other supplements. Results expected by modern breeding programs will be achieved when the higher level of knowledge in selection, rearing technology and management are accompanied with environmental conditions appropriate for excellent forage production. On the other hand, the economics of milk production based on large-scale farms which cultivating large areas and rearing hundreds or even thousands of cows. Due to high competition in the market with raw milk, positive results could be achieved only by the constantly improving technology and production increasing (Roberts, 2009).

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Farms in the hilly and mountainous areas have no environmental conditions for the forage production of sufficient quality. They even haven't enough land to achieve the production size that enables competitiveness. On the other hand, such breeders could use the semen of sires which are selected on high production. In such conditions, the interaction between genotype and environment is more expressed (Mulder et al., 2006). This is reflected in lower production according to the genetic potential and breeders' expectation. However, breeders' expectations are consistent with the genetic values of sires and data included in sire catalogues. These data are based on breeding programs assuming top management on the farm.

The interaction between genotype and environment causes that sire with a high potential for milk production achieved lower results compared to sire selected for modest conditions. This fact reduces the competitiveness of farms beside the limited production size. The long-term existence of farms in such circumstances is endangered. The consequences of farming abandonment in such areas are wide-ranging. In addition to the unemployment of farmers and family members, there are still negative macro-economic effects, which are particularly evident in losing cultural landscapes (overgrowing), reduced national self-sufficiency and ultimately loss of farming knowledge and skills. Uncultivated landscape is less attractive for tourism as well (general discussion in the European Congress of the Brown Swiss Breeders, Kempten, Germany, 2014).

Regarding the facts described above it's necessary to prepare a breeding program in terms of competitiveness, adapted to the restricted environmental conditions for high production. According to lower production there is needed to implement added value to increase the competitiveness. Many breeders have already achieved it with increased quantity of raw milk and dairy products sold on the farm.

In the case of selling directly to the consumers it makes sense to offer them a higher quality. One of options is hay milk produced in organic conditions which becomes more and more attractive. In the future would be necessary to consider some traits showing a specific higher quality of milk and dairy products.

The most important trait for the breeders who produce cheese is the milk composition which resulted in higher cheese yield. This trait is highly related to cow genotype for kappa casein (Aleandri et al., 1990; Wedholm et al., 2006). Recently it was discovered that milk casein composition affects the consumers' health as well. The most commonly mentioned is beta casein, where occurred a mutation in cattle in this gene. Etiologists indicating that mutated allele of beta casein could be responsible for initiating certain diseases, such as cardiovascular disease, diabetes and neurological disorders like autism and schizophrenia (Stacey et al., 2006).

The selection on the increased frequency of B allele for kappa casein allows production of higher cheese yield from the same milk yield. This has also positive effects on milk coagulation time and curd firmness, which improves the economics of milk processing (McLean et al., 1984; Lundén et al., 1997; Boettcher et al., 2004; Buchberger and Dovč, 2000; De Marchi et al., 2014; Jõudo, 2008).

The selection on higher frequency of the so-called original (A2) allele of beta casein could be incorporated into brand mark for the specific milk quality as well as the quality of dairy products produced from such milk (Santus and Eagle, discussion in Interbull meeting, Orlando, USA, 2015). Biological background of beta casein mutations and potential effects on human health were described by many researchers (Phelan et al., 2009; De Noni, 2008; Bell et al., 2006; Truswell, 2005). These findings were implemented for the first time by New Zealand breeders. In the year 2007 was reported that 500 breeders were associated together.

They were excluded from breeding herds those animals which had one or both mutated (A1) alleles (Woodford, 2009). However, the first evident marketing of "A2 milk" is from New Zealand as well, where Dr. Corran McLachlan was established a very successful company "The a2 Milk Company™" (http://thea2milkcompany.com) in the 2000.

Implementation of beta and kappa casein traits in breeding program as well as adapting breeding objectives to the restricted rearing conditions make sense especially in the population of brown cattle. This dairy breed originated from the Alpine region and has the most favorable frequency of desired allele for beta (Kaminski et al., 2007) as well as for kappa casein (James, 2012) among all central European cattle breeds.

Material and Methods

Proposal of an alternative breeding program is based on the analysis of sampled animals from Slovenian Brown Swiss population and on the characteristics of some good practices of niche production.

Sampled animals were represented by 34 male and 6 female calves. They were genotyped for the purpose of genomic selection, which is a routine procedure in Slovenian Brown Swiss population from the year 2013 (Špehar et al., 2014). Animals were not randomly chosen, because they would be potentially breeding animals according to genomic breeding values and accepted breeding program. The results of genotyping were processed according to the routine procedure. DGV of longevity, production index and total merit index were used in this study. In addition, the results for the beta and kappa casein were obtained as well.

A comparison among DGV for longevity, production index and total merit index depending on genotypes of studied caseins was performed. Data were processed in the statistical package SAS/STAT (SAS, 2014). DGV were shown on a standardized scale (mean was 100 and standard deviation was 12 points).

Characteristics of good practices with marketing of special milk quality and marketing of breeding animals with desired beta and kappa casein genotypes were studied from personal and literature sources.

Results and Discussion

Slovenian cattle populations are small and most of herds are reared in marginal areas which not allow higher milk production. Farms in these areas cannot compete with larger capacity farms with better rearing conditions considered in breeding programs of modern dairy breeds. In recent years, especially in New Zealand and Australia and in some European countries they started trading milk and dairy products with desirable kappa and/or beta casein as well as breeding animals with genotype for kappa and/or beta casein.

Trading of milk with desired genotype for beta casein (A2 milk) began in New Zealand where the "A2 Milk Company™" was established in the year 2000. In the beginning A2 milk were traded through New Zealand and Australia. In last years, trading expanded in UK, USA and China. The quantity of sold milk is now the highest in New Zealand and Australia. For the 2016, it is estimated the increased proportion of sold A2 milk in China, UK and USA (http://thea2milkcompany.com/). A2 milk is especially traded as an infant formula. Similar situation were found in the Netherlands, where breeders promote and trade milk and dairy products of Guernsey cattle, which is known as a dairy cattle with the highest proportion of A2 allele for beta casein (http://www.guernsey-butter.com/).

Some insemination centres (AI) started selling sires with the genotype A2A2 for beta casein. There are known some cases in the Ayrshire cattle (http://www.cattleservices.org/), most of Australian cattle breeds (http://www.absglobal.com/a2-sires) and in Italian Holstein cattle (http://Issuu.com/jservice/docs/INSEM-catalogo-apr2015?e=1279172/12387549).

The importance of cheese yield-related traits is known quite long time where kappa casein is considered as the main factor. Allele B is the most preferred. In Slovenia, the genotype for kappa casein is presented in sire catalogues for a long time. Despite this fact, sires were traded with the emphasis on production traits. The main reason is that dairy industry not paying more money for milk with a higher content of kappa casein. Regarding kappa casein content in milk, an interesting situation took place in Switzerland (James, 2012; Berger, 2012) where the introduction of E allele for kappa casein was so high that cheese production was no economically justified. The most important effect had using of semen belonged to very popular sires Picston SHOTTLE-ET GB 598172 and Sandy-Valley BOLTON ET US-131823833, which have AE genotype for kappa casein (Andreas, 2013 - personal communication). Milk produced by cows with E allele for kappa casein is used just as consume milk.

In the sampled animals from Slovenian Brown Swiss population occurred only two alleles for kappa casein, A (26.25%) and B (73.75%). Considering Hardy-Weinberg equilibrium the expected frequency of genotypes would be as follows: AA (6.9%), AB (38.7%), and BB (54.4%). According to the sample size expected frequencies are relatively similar to observed results (Table 1). This is good result compared with other breeds. On the other hand, in the Italian Brown cattle the proportion of desired allele is 15% higher compared to sampled animals in Slovenia. The selection on kappa casein in Brown Swiss cattle in Italy is very successful. In the last 17 years, the frequency of B allele increased from 62% to 84%, which is more than 1.2% per year (ANARB, 2015).

The frequency of alleles for beta casein in the sampled animals from Slovenian Brown Swiss population were 22.5% for A1 allele and 75.5% for A2 allele (Table 1). Considering Hardy-Weinberg equilibrium the expected frequencies of genotypes would be 5.1% (AA), 34.8% (AB) and 60.1% (BB) what is very similar to observed frequencies (Table 1). The frequency of allele A2 in Slovenian Brown Swiss animals is higher than in others Brown Swiss populations. Higher frequency of A2 was found just in Guernsey cattle (EFSA, 2009).

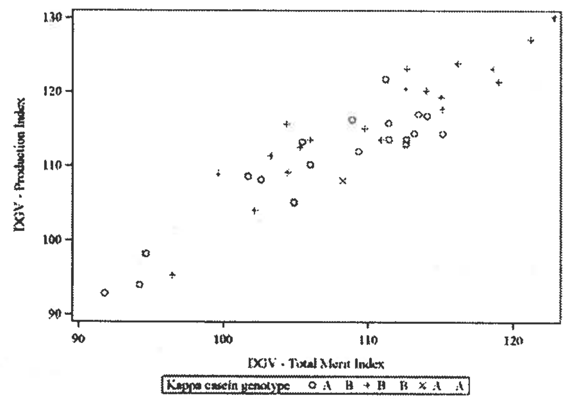
Table 1. Number of sampled animals according to determined beta and kappa casein genotype

Kappa casein genotype	Beta casein genotype			
	A1A1	A1A2	A2A2	Total
AA	0	0	1	1
AB	2	11	6	19
BB	0	3	17	20
Total	2	14	24	40

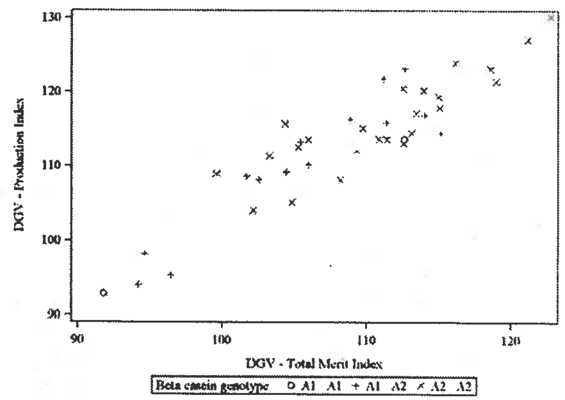
Comparison of observed frequencies of genotypes for both caseins and expected frequencies calculated based on the assumption that the population is in Hardy-Weinberg equilibrium, indicating that sampled animals is representative of Slovenian Brown Swiss population.

The combination of genotypes for kappa and beta casein indicated that most of sampled animals (42.5%) were in the class with the desired genotypes for both caseins. The second group (27.5%) of animals possed all four forms of alleles (Table 1).

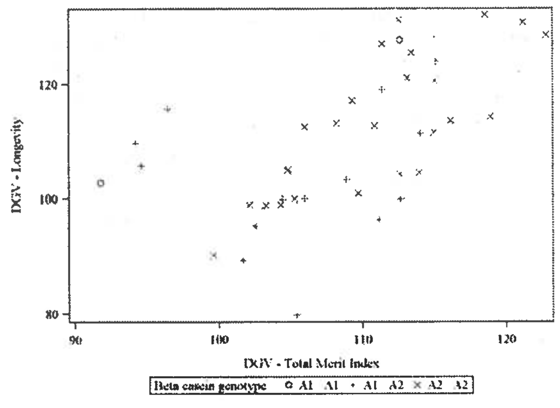
The comparison among genotypes of kappa casein and the DGV for production index and total merit index were performed. It was found that 10 animals with high DGV for both indexes had preferred genotype for kappa casein as well (Graph 1). Likewise, very similar it could be concluded for beta casein genotypes (Graph 2).



Graph 1. Relationship between DGV for production and total merit index by Kappa casein genotype



Graph 2. Relationship between DGV for production and total merit index by beta casein genotype



Graph 3. Relationship between DGV for longevity and total merit index by beta casein genotype

When comparing DGV for longevity with DGV for total merit index by beta casein genotype (Graph 3) completely different results were found. Twelve animals with the desired genotype for beta casein had both DGVs more than one standard deviation higher to the average of sampled animals. Among animals with such a high DGVs was also an animal with an undesired genotype and two of them that had both alleles of beta casein.

Conclusion

In the restricted environmental conditions where high production cannot be achieved breeding goals need to be adjusted in the given conditions what allow economical farming. The current level of production need to be reduced to the quantity of forage produced on an average farm. In the same time, fertility and longevity have to be improved with integrating functional traits with higher weights in total merit index. In order to achieve specific quality it makes sense to intensify the selection on beta and/or kappa casein. In the case of Slovenian Brown Swiss it is reasonable to select on both caseins at the same time.

Selection for caseins could be done in several paths. By male line, only breeding sires with desired genotypes need to be selected. The preferred result will be achieved rapidly when female line is selected as well. In that case, it is necessary to improve fertility and longevity, to have enough heifers with desired genotype for replacement. When more exceptions are allowed, the results are achieved later. With strict selection, in the ideal conditions desired alleles will be fixed. After that, all offsprings will have desired genotypes for studied caseins and further selection will base only on quantitative traits.

The farming economics in a herd is possible to enhance with an analysis of both caseins when milk is processed or sold on the farm. When milk is processed, only milk produced by cows with the BB genotype for kappa casein need to be used to increase the cheese yield and to improve the economics of cheese making. When consume milk is traded and we want to add it value it is necessary to milk only cows with A2A2 genotype for beta casein. Even in the case of milk processing, it is appropriate to include the selection for beta casein and market products under the brand A2.

The herd selection could be carried out as described for the population. However, an effective method is to exclude cows with undesired alleles and replace them with cows which have a desired genotype for both caseins. When is achieved the fixation of desired alleles in a herd, it is only necessary to select appropriate sires regarding genotypes. There is no need to genotyping offsprings because all of them will have desired alleles.

This approach leads to the long term competitiveness of milk production and processing in restricted areas. Milk and dairy products with a special quality will achieve a higher market price. Secondary effects of such an approach would be expressed in a higher value of cattle population, populated rural areas, preserved cultural landscape, higher touristic potential and higher employment.

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MODERN CONCEPT OF THE SHEEP PRODUCTION IMPROVEMENT

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*Abstract:*In our country sheep production does not represent the most important branch of animal husbandry. Sheep production is mainly present in the Sumadija and Western Serbia region where 60% of the total number of sheep in entire republic is being bread. Sheep production is dominant at small and medium size farms where average number of sheep per farm is 11 animals.

Intensive sheep production today is based mainly on genetic potential and sheep life cycle, with the goal mainly to increase biologic base potential for sheep breeding process.

Nowadays it is possible to make transit from seasonal semi cycle to full cycle and sheep insemination during entire year by applying intensive diet and biologic stimulants.

Breeding system and productivity control opens up new perspective of efficient usage of our sheep funds with goal to produce high quality mutton for domestic and world market.

Keywords: Sheep production, biotechnology methods, breeding, selection.

Intoduction

When it comes to significance sheep production is fourth branch of animal husbandry production in Republic of Serbia. For the year 2011.sheep production share in total animal husbandry production was 3,5% . At 155 thousand farms there is 1.74 million sheep bread (Popović, 2014).

Sheep production is mainly present in the Sumadija and Western Serbia region where 60% of the total number of sheep in entire republic is being bread. Number of sheep per acre of agricultural land in this region is one per acre. Difference between northern and southern regions when it comes to sheep production is 20% : 80% . Lowest sheep population density is in Vojvodina area, where there are only 0,17 sheep/ha of arable agricultural land. Number of sheep between two censuses decreased from 4.3 to 1.7 million of sheep, which was also followed by decrease of number of farms that keep sheep.

Sheep breeding is mainly concentrated at small farms. Category of small farms are 76% and medium size category are 21% of farms. These two categories breed 58 and 32% of all sheep. Large farms according to economy criteria have share of only 3% in total number of

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