



Effect of climate and season of calving on genetic parameters of production and somatic cells in Holstein cows

REZA NESHAGARAN HEMMATABADI¹, GHOBAD ASGARI JAFARABADI^{2✉}, NASER EMAM JOME KASHAN³
and MEHDI AMINAFSHAR³

Islamic Azad University, Tehran, Iran

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ABSTRACT

Records (111543) of first calving test day milk production with three milking times during the years 1983 to 2016 were used for 62 herds in the Breeding Center data file. The dairy cows under study had 10 test day records. Variables from the herd-year-calving combination as random effect and herd-test-month-age combination at the time of record as fixed effects were created for each animal. Average milk yield in hot and dry climate was higher than hot and wet climate. The average traits of milk fat and milk protein percentage in hot and dry climates were higher than hot and wet climates, but somatic cell traits were higher in hot and wet climates. The phenotypic variance of milk yield was higher in hot and dry regions in all ten test day records. The phenotypic variance of milk fat percent was higher in hot and dry area on the first, second, fifth and sixth test days. The average genetic variance of milk fat percentage in hot and wet region at 9 test day records was higher than in hot and dry region. Phenotypic variance of milk protein percentage in hot and dry area was higher than in hot and wet regions in all test days. In countries where calving occurs throughout the year, mastitis is dependent to the pattern of growth of pathogens in different seasons and years. Changes in animal physiological conditions (calving and changes in breast status) increase the number of somatic cells in milk, which has a physiological effect.

Keywords: Climate and season of calving, Genetic and environment interaction, Somatic cells

Productive traits are important in the selection of dairy cows to increase economic profit (Rekik *et al.* 2003). Togashi *et al.* (2008) discussed the crucial importance of animal genetic resources in food health and safety. Breeding of domestic livestock will work best when all strategies are tailored in a specific way (Miller *et al.* 2004). Generally, the goal of breeding dairy cows is to change yields and increase economic productivity. Most breeding programs are based on increasing production traits, but in increasing production through genetic improvement it is necessary to consider other traits in addition to milk yield. To determine the degree of effectiveness or response to selection, one must examine genetic and environmental changes and evaluate the success of breeding programs over the years with the genetic trend (Strabel and Misztal 1999). Milk production is the most important source of income for livestock farmers and high-yielding cows are more profitable. However, high production is associated with reproductive problems and a decline in animal health

(Boichard and Rupp 1997). Genetic selection programs in recent years have led to significant advances in milk production and in turn caused to declining trend in fertility, survival and disease resistance (Veerkamp *et al.* 1994). Because of the negative genetic correlation between milk yield and mastitis resistance, resistance to mastitis has decreased due to selection for milk production (Boichard and Rupp 1997). Inflammation of the mammary glands causes invasion of somatic cells—predominantly multinuclear neutrophils—leading to an increase in the number of somatic cells in milk. Therefore, the number of somatic cells in the raw milk is an indicator that indicates the probability of microbial infections and mastitis (Faraji *et al.* 2012). The phenotypic relationship between somatic cells and milk production trait is negative and with increasing milk production the number of somatic cells decreases (Pryce *et al.* 1999). Increase of different types of somatic cells caused by stresses such as changes in the diet, seasonal changes, the frequency of milking, is the effect of a particular stage of milking or a combination of these. Holstein cows perform better in a given climatic range, because adverse climatic conditions of the breeding environment increase environmental variance and the livestock is affected by adverse environmental conditions and its genetic capacity is not fully apparent (Koc 2008).

Present address: ¹Science and Research Branch, Islamic Azad University, Tehran, Iran. ²College of Agriculture, Varamin-Pishva Branch, Islamic Azad University, Varamin, Iran. ³College of Agriculture and Food Sciences, Tehran Science and Research Branch, Islamic Azad University, Tehran, Iran. ✉Corresponding author email: naser_ejk@yahoo.com

Since breeding traits are most important in breeding programs, it is necessary to study the genetic parameters of Holstein cattle due to their different performance in different environmental conditions and their high genetic capacity. Several environmental factors affect the production and composition of milk, including the breeding season. Since climatic and environmental conditions are not the same in all regions of the country in a given season, it is necessary to study the effect of conditions and seasons on production changes and genetic parameters in order to increase production in each region.

Therefore, the purpose of this study was to study the effect of climate and season of calving on genetic parameters of production and somatic cells in Iranian Holstein cows in two hot and wet climates (Mazandaran and Gilan provinces) and hot and dry climate (Isfahan and Tehran provinces).

MATERIALS AND METHODS

In this experiment, in order to study the effect of climate and calving season on genetic parameters of milk production and somatic cells in Holstein cows (or in other words study the interaction of genotype and environment on genetic analysis of milk production and somatic cells using test day records), data collected by the National Livestock Breeding Center were used.

In this research, pedigree files and information from the years 1983 to 2016 were used so that the pedigree file contains columns including animal number, herd code, birth weight, inbreeding percentage, birth date, cancel date and numbers related to their parents. It should be noted that the animal numbers must be larger than the parent numbers. In order to provide pedigree file, all information and registration numbers of the studied animals were used until all registered family relationships are taken into account. In addition to the above information, data file including season and year of birth, record date, age of delivery, milk

production record, lactation day, sperm count used, milk protein percentage, milk fat percentage, body cell score, calving period and number of calving separately. Therefore, it is necessary to study the phenotypic performance of at least two genotypes in at least two different environments, and in this study, different male cows were studied as different genetics and differences in animal performance and milk yield, protein percentage and milk fat as different environment.

After editing the data, the records of 111,543 Holstein dairy cows (daughters of 472 bull) were used in the first lactation of 142 herds from two regions of six provinces. The Advanced De Martonne method (De Martonne 1926) was used that is done according to the mean annual precipitation and mean annual temperature. According to the information provided by the provinces of the country, the provinces are divided into the following five climatic groups: 1, Desert arid including Khorasan Razavi, Sistan and Baluchistan, Yazd, Qom provinces; 2, Semi-arid including Khorasan Razavi, Tehran, Isfahan, Fars, Hamedan provinces; 3, Mediterranean including Ilam, Qazvin, Kermanshah, Kurdistan provinces; 4, Semi-wet including Mazandaran and Golestan provinces; 5, Wet, including Gilan province. Therefore, the edited data in this study were divided into two groups of hot and wet and hot and dry parts, so that the part of hot and dry including Isfahan, Yazd and Shiraz provinces and hot and wet parts including Golestan, Mazandaran and Guilan provinces. As for the use of test day data, Reaction norm method was used to investigate the interaction between genotype and environment.

RESULTS AND DISCUSSION

Comparison of the mean milk yield in the two studied climates showed that the average milk production of Holstein cows on different lactation days in hot and dry

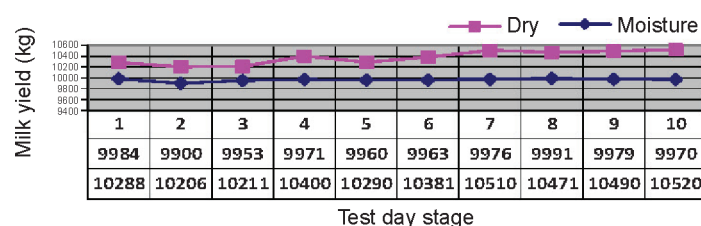


Fig. 1. Comparison of the mean milk yield in the studied climates

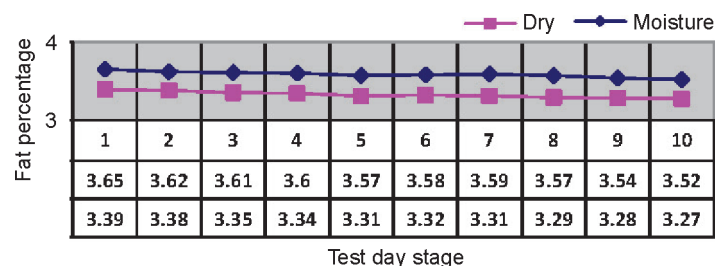


Fig. 2. Comparison of the mean milk fat percentage in the studied climates

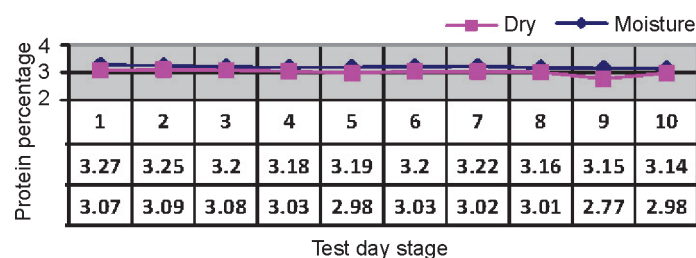


Fig. 3. Comparison of the mean milk protein percentage in the studied climates

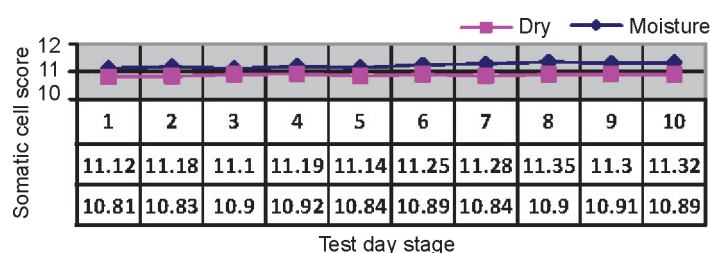


Fig. 4. Comparison of the mean score of milk somatic cells in the studied climates

climates had higher yield than the hot and wet climates. Figure 1 shows that milk production in hot and dry climates increased with increasing lactation days, whereas the increase in milk production in hot and wet climates was negligible.

Figure 2 shows that the amount of milk fat produced in hot and dry climates during all lactation days is higher than in hot and wet climates. It should be noted that, the trend of the amount of milk fat percentage from the early days to the end of lactation was observed with a decreasing mild approximately parallel slope in two different climates.

Fig. 3 shows that the average trend of milk protein percentage in hot and dry climates decreased from day 1 to day 4, increased from day 5 to day 7, and decreased again from day 8 to day 10; but the average milk protein percentage in hot and wet climates increased on the second test day compared to the first test day and then a decreasing trend was observed to the tenth day. As for this trend, the average milk protein percentage was higher in hot and dry climates than in hot and wet climates.

Figure 4 shows that the mean score of milk somatic cells in hot and wet climates was significantly higher than in hot and dry climates. The mean score of milk somatic cells in hot and wet climates had an increasing and decreasing trend during lactation. The mean score of milk somatic cells in hot and dry climates increased from day 1 to day 4 as well as days six, eight and ninth compared to their pre-test days and declined in the rest of test days.

Boalgo *et al.* (2013), Tijani (2012) and Biasos *et al.* (2011) stated that milk production increased at the beginning of the period and peaked at day 54 of lactation, and then production declined until the end of the period. Moharrary (2011), Tiezzi *et al.* (2017), Montaldo *et al.* (2017), Moreira *et al.* (2019) and Fazel *et al.* (2019) also reported similar results. Biasos *et al.* (2011) stated that protein and fat production increased at the beginning of the period and peaked at day 80 and 50 of lactation respectively, and then

production declined until the end of the period. Also, Tijani (2012), Boalgo *et al.* (2013), Kissmas *et al.* (2012), Khanzadeh *et al.* (2013), Gurmessa and Molako (2012), Bohmanova *et al.* (2009) and Moharrary (2011) reported similar results.

Baol *et al.* (2007) reported that the number of somatic cells decreased from the highest in the early period to the lowest in the middle of the period and then increased to the end of the period. Moharrary (2011) stated that there was a positive correlation between lactation and body cell count. According to the present study, Pakdel *et al.* (2010) stated that the number of somatic cells in the first month of lactation was lower and gradually increased in subsequent lactation months. The reason for the increase in the number of somatic cells in the higher lactation months can be attributed to the greater willingness of lactating cattle to develop mastitis at older ages and to decrease milk production. Dube *et al.* (2008) reported an average body cell score in primiparous Holstein cows of South Africa's of 4.47 and reported that it was higher than in other countries. Zong-yun *et al.* (2007) reported an average body cell score in Holstein Chinese cows of 2.25. Also, Miller *et al.* (2004) reported a mean milk cell score in the primiparous cows of the US Dairy Herd Improvement Association of 2.85, which is roughly comparable to the mean of the primiparous Holstein cows in Iran. Lotfi Noghabi and Farhang Far (2007) showed that the effect of season, month, year and herd on body cells of milk tank of Mashhad was significant. They observed three peaks for the number of milk cells in May, August and February. Given the trend in milk cell counts, it is clear that management programs in the herd are mastitis treatment and that mastitis control and identification programs are not performed permanently. Van der Lak *et al.* (2016) and Tiezzi *et al.* (2017) also reported similar results as obtained in the present study.

Generally, differences in rainfall and climatic conditions in different regions of Iran and even in different years can

lead to different results. In countries where calving occurs throughout the year, mastitis is dependent to the pattern of growth of pathogens in different seasons and years (Baltay 2002). But when seasonal conditions are not conducive to the growth of microorganisms, changes in animal physiological conditions (such as calving and changes in breast status) increase the number of somatic cells in milk, which has a physiological effect.

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