INBREEDING AND ITS EFFECTS ON MILK AND FAT YIELDS OF IRAN HOLSTEINS

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INTRODUCTION

In recent years the widespread use of few genetically superior and outstanding proven sires has caused concern the industry with inbreeding problems. Inbreeding is the mating of animals that are related. It makes pairs of genes alike and thus may reduces genetic diversity of each animal and has harmful effects on production and reproduction traits (Falconer, 1989). The harmful impact of inbreeding on milk production traits has been reported in many studies. Miglior (1994), using records of Canadian Holstein cows, reported that on average the inbreeding depression per each 1% increase in inbreeding is 24.8 kg and 0.9 kg, respectively, for milk and fat yields. For U.S. Holstein cows, estimates were much larger, and were –29.6 kg and –1.1 kg (Wiggans, et al., 1995) and –37.0 kg and –1.0 kg (Cassell, 1999), respectively, for milk and fat yield for each 1% increase in inbreeding. For Iran Holsteins, there is no investigations dealing with inbreeding. The objective of present study was to calculate level of inbreeding and estimate the inbreeding depression on milk and fat yields for Iran Holstein population.

MATERIALS AND METHODS

Pedigree information. A pedigree information of 382831 registered Holstein cows and bulls, collected by Animal Breeding Center of Iran (ABCI) from 1979 to 2000, was used in this study. Inbreeding coefficient (F) of each animal was calculated using a program written by Sargolzaei (2000) based on Meuwissen and Luo (1992) algorithm. Ninety-four percent of animals in pedigree file were female and 6% were male. Also, 64%, 65% and 58% of animals had known sire, known dam and known sire and dam, respectively. The base population year was considered to be 1968 with inbreeding coefficient of zero, and therefore the trends of the inbreeding were calculated since then.

Inbreeding Depression. A total of 60589 cows records for the first lactation, collected during 1993 to 2000 by Animal Breeding Center of Iran, were used to estimate the effect of inbreeding on milk and fat yield. The following single-trait animal model was fitted to the data:

$$\mathbf{y} = \mathbf{Xb} + \mathbf{Za} + \mathbf{e}$$

where $\mathbf{y}$ is the vector of first lactation milk or fat yield, $\mathbf{b}$ is the vector of fixed effects, including herd-year-season, age at calving and inbreeding coefficients, $\mathbf{a}$ is the vector of additive genetic effects, $\mathbf{X}$ and $\mathbf{Z}$ are design matrices for $\mathbf{b}$ and $\mathbf{a}$, respectively, and $\mathbf{e}$ is the vector of random residuals. The age at calving and inbreeding coefficients were fitted as

covariate in the model. Data were analyzed by restricted maximum likelihood procedures, using the DFREML program (Meyer, 1997).

RESULTS AND DISCUSSION

Inbreeding. The descriptive statistics for inbreeding coefficient for the whole and inbred population are presented in Table 1. The average inbreeding coefficient was 0.18% for all bulls and cows, 0.18% for cows and 0.24% for bulls population. The lowest inbreeding coefficient computed was 0 and the highest was 39.84%. For inbred animals, average inbreeding coefficients were 2.18% for bulls and cows, 2.14% for cows and 2.72% for bulls population. It seems that these estimates could be lower than the actual inbreeding of the population due to their incomplete pedigree data structure. It has been reported that average inbreeding coefficient for animals with known sire, dam and at least one grandparent is 48.0% lower than the average inbreeding coefficient of animals with a minimum of four generations of complete pedigree data (Cassell, 1999). In general, the average inbreeding coefficient obtained in the present study was lower than reported studies. Miglior (1994) reported an average inbreeding of 1.90% for bulls and 1.70% for cows in Canadian Holstein population. For U.S. Holsteins, average estimate of inbreeding was 2.60% for the whole population (Wiggans, *et al.*, 1995).

Table 1. Average inbreeding coefficient (%) of cows, bulls, and cows and bulls population

	Whole population			Inbred population		
	Bulls+Cows	Cows	Bulls	Bulls+Cows	Cows	Bulls
No of Animals	382831	359698	23133	32377	30333	2044
Mean	0.184	0.180	0.240	2.175	2.138	2.719
Standard error	0.002	0.002	0.009	0.022	0.023	0.084
Minimum	0	0	0	0.002	0.002	0.003
Maximum	39.844	39.844	25.780	39.844	39.844	25.780

The distribution of animals for different classes of inbreeding is presented in Table 2. The results indicated that most of animals were non-inbred (91.2%, 91.6% and 91.5% for bulls, cows, and bulls and cows population, respectively). A large number of inbred animals (7.5%) in both cows and bulls population had inbreeding coefficient > 0 and ≤ 6.25%. The distribution of inbred animals decreased substantially to 0.6%, 0.2%, and 0.2%, respectively, for inbreeding >6.25% and ≤12.50%, >12.50% and ≤18.75%, and >18.75. The lower number of animals with high inbreeding coefficient in this study clearly indicates that breeders tend to avoid of mating between close relatives.

The average inbreeding coefficients over years of birth of all animals from 1979 to 2000 are shown in Figure 1. For the whole population, three distinguishable periods can be observed. The average inbreeding coefficients per year in the first period (from 1979 to 1984) was negligible (0.002%), probably due to the lack of pedigree information. In second period, from 1985 to 1990, a steady increase in inbreeding per year was observed (0.008%) mainly due to avoidance of mating between related animals. From 1991 onwards (third period), the increase in inbreeding coefficients per year were substantially higher (0.052%) than second period. This

increase can be attributed to the more attention of breeders for identification of animals, pedigree recording and using a few proven sires. For cows population, a similar pattern was observed, but for bulls population, there was a large fluctuation in average inbreeding over years.

Table 2. Distribution of cows and bulls for different classes of inbreeding (%)

	Bulls+Cows		Cows		Bulls	
Classes	No	%	No	%	No	%
F=0	350454	91.54	329365	91.57	21089	91.16
0<F≤6.250	28719	7.5	27034	7.52	1685	7.30
6.250<F≤12.50	2350	0.60	2084	0.58	226	1.15
12.50<F≤18.75	724	0.20	660	0.18	64	0.28
F>18.75	584	0.15	555	0.15	29	0.13

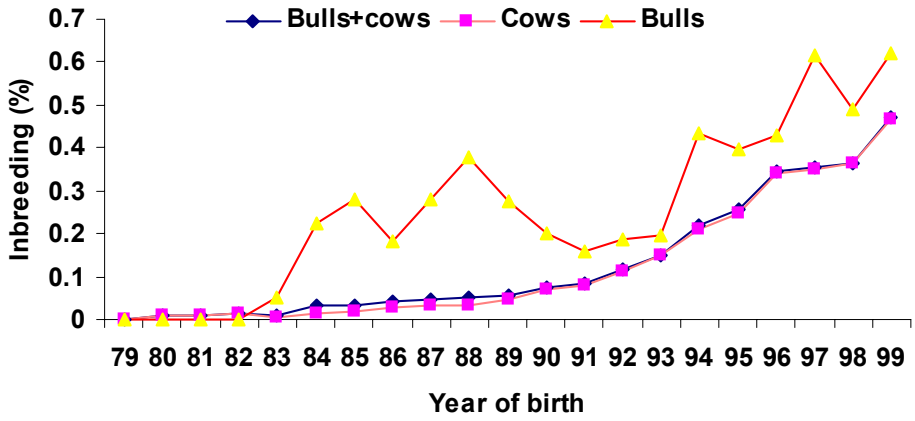

Figure 1. Average inbreeding coefficients within year of birth

Effect of inbreeding. Of all 329365 cows, only 16.8% had first lactation records. The average and maximum inbreeding coefficient of these cows were 0.25% and 26.56%, respectively. For both milk and fat yields, 10.8% of cows were inbred. Estimates of inbreeding depression for milk and fat yields are shown in table 3. Results indicated a reduction of 12.45 kg and 0.39 kg, respectively, for milk and fat yields per 1% increase in inbreeding. Literature results were almost higher than present study. For example, Short *et al.* (1992) and Wiggans *et al.* (1995) reported estimates of –22.6 kg and –29.6 kg for milk yield and –0.78 kg and –1.08 kg for fat yield for U.S. Holsteins. This estimate for the first lactation milk yield was reported to be much higher (-37.0 kg) for the same population (Cassell, 1999). Miglior (1994) also reported negative impact of inbreeding on milk (-24.78 kg) and fat (-0.90 kg) yields for Canadian Holsteins.

Table 3. Inbreeding depression (kg/1% inbreeding) for the milk and fat yields

Trait	Milk	Fat
Inbreeding depression	-12.452	-0.393

CONCLUSION

The average inbreeding coefficient of 0.18% for the whole population of Iran Holsteins were lower than most available reported literature. Also, increase in the pattern of inbreeding coefficients of animals per year was similar to those studies. However, the amount of changes was smaller in present study. Comparison of the reported results with the results of this study showed that the influence of inbreeding on milk and fat yield for Iran Holstein population was low, which could be attributed to no great amount of the level of inbreeding and large number of non-inbred animals.

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