Research paper

Incidence of inbreeding and its influence on performance traits in Sahiwal cattle

Shabahat Mumtaz and Anupama Mukherjee*

Animal Genetics & Breeding Division, ICAR-National Dairy Research Institute, Karnal, (Haryana) India

ABSTRACT

Pedigree and performance records of 1712 Sahiwal female maintained at ICAR-National Dairy Research Institute, Karnal pertaining to the period between1974 to 2018 were utilized for present study. Present investigation was carried out to find out the influence of inbreeding on various performance traits in female population. Data is adjusted for non genetic factors namely season/period of birth for age at first calving and season/period of calving for first service period, first calving interval, first lactation 305 days or less milk yield, first lactation length, first lactation total milk yield, first dry period, first lactation 305 fat yield and first lactation 305 solid not fat yield the data pertaining to first lactation traits considered. The data was classified into 5 inbreeding groups including non-inbred group to study the influence of inbreeding on above traits by taking inbreeding as a fixed effect by using least square analysis of variance. The inbreeding coefficient of Sahiwal female population was 2.21% and inbred female was 3.7% ranging from 0.01 to 20%. Most of the traits were non significant only age at first calving were statistically significant (P≤0.01) among various inbred groups. The main reason of low level of inbreeding firstly was implementation of optimum breeding strategies that leads to introduction of new genetics variants and culling of animals to avoid mating of related ones in the herd and secondly due to incompleteness of pedigree especially for animals born in earlier years with unknown pedigree mainly founders. Although there was no inbreeding depression in most of the traits but inbreeding effect were showing slightly increasing trend on service period and calving interval so more precise pedigree recording and planned mating strategies should be adopted to avoid inbreeding depression in future generation.

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***Corresponding author:** writetoanupama@gmail.com
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INTRODUCTION

Livestock plays an important role in national economy and socio-economic development of the country. It helps in the rural economy by supplementing family income and generating gainful employment particularly among the landless, small and marginal farmers and for women. Sahiwal is one of the best milch breed of India known for their higher milk production maintained since more than four decades in NDRI, with systematic recordings of all the performance traits. Modern animal breeding programs, which are characterized by the accurate estimation of breeding values and the use of advanced reproduction techniques, lead to rapid genetic progress but increase inbreeding through the strong impact of few individuals or families selected (Weigel, 2001). This fact has been a matter of concern for researchers worldwide, who attempt to determine and overcome the damaging effect of inbreeding on animal performance (Queiroz *et al.,* 2000; Falcao *et al.,* 2001; Gonzalez-Recio *et al*., 2007; Gomez *et al*., 2008). As a consequence, homozygosity increased that increases frequency of deleterious recessive genes in the population. Inbreeding depression is the result of inbreeding and a decrease in the average phenotypic performance of animals. Inbreeding depression can be defined as a linear function of the inbreeding coefficient. However,

according to (Lynch and Walsh 1998), if epistatic interactions are considered as a mechanism to explain the genetic basis of inbreeding depression, the decline in the phenotypic mean can be defined as a nonlinear function of the inbreeding coefficient. Maintenance of genetic variation at an acceptable level by controlled inbreeding is of great importance and will ensure that animals in the future can respond to changes caused by selection (VanWyk *et al.,* 2009).

MATERIALS AND METHODS

Pedigree and performance records of a 1712 Sahiwal female maintained at ICAR-National Dairy Research Institute Karnal pertaining to the period between 1974 to 2018 were utilized for present study. Data were collected on reproduction and production performance of Sahiwal cattle from history cum pedigree sheets from Animal Genetics and Breeding (AG&B) division and Livestock Research Centre (LRC) from ICAR-NDRI, Karnal. The records of the Sahiwal with known pedigree will be taken for calculation of inbreeding coefficient. The animals with abnormal records like abortion, still birth, delayed calving and other reproductive problems will not considered for association studies with inbreeding coefficient. The data was edited and normalized resulting in 599 Sahiwal cows for further analysis.The coefficient of inbreeding was estimated by Wright's method. The data was classified for non genetic factors on the basis of season of birth/calving and period of birth/ calving. The traits included in the study were Age at first calving (AFC), First service period (FSP), First calving interval (FCI), First lactation 305 days or less milk yield (FL305DMY), First lactation total milk yield (FLTMY), First lactation length (FLL), First dry period (DP), First lactation 305 fat yield (FL305FY) and First lactation 305 solid not fat yield (FL305SNFY).The data was classified on the basis of inbreeding level into 5 groups including non-inbreds. To quantify the change on various performance traits with unit change in inbreeding value simple regressions analysis was carried out.

Statistical analysis

The data was analysed using Least Squares analysis technique (Harvey,1975) to found out the effects of season and period of birth on AFC, season and period of calving on FSP, FC, FL305MY, FLTMY, FLL, FDP FL305FY and FL305SNFY. Duncan's Multiple Range Test (DMRT) was used to test the significance of differences between treatments' means.

The models used for analysis are as given below:

a) Performance traits

$Y_{ijk}=\mu+S_i+P_j+e_{ijk}$

b) Effect of inbreeding on various traits

$Y_{jk}=\mu+IB_j+e_{jk}$

RESULTS

The effect of period of birth was only significant on AFC ($P\leq0.01$) and the effect of season of calving is non significant for all the traits except for FL305MY ($P\leq0.01$) and period of first calving were significant ($P\leq0.01$) on all the traits. The adjusted data was analysed to see the influence of inbreeding on various production and reproduction traits in Sahiwal cattle.

Incidence of inbreeding

The average inbreeding coefficient of Sahiwal females was 2.21% and inbred was found to be 3.7% ranging from 0.01 to 20% over a period of 45 years. After ignoring animals in foundation stock, the remained 1712 females and out of which 695 were non-inbred and 1017 were inbred (Table 1). Among the inbreds the maximum number of females occurred in the range of coefficient of inbreeding 0.0 to 3% followed by the group with inbreeding range from 3.01 to 6%, 6.01 to 9% and there were only 1.28% of cows with inbreeding coefficient greater than 9.01%.

Effect of inbreeding on reproduction traits

The differences in average age at first calving among various inbreeding groups (Table 2) were statistically significant ($P\leq0.01$). The average AFC was not statistically different upto 6% inbreeding level, thereafter from 9% onwords increased significantly. For all inbred animals, the AFC was greater than that of non-inbred. The differences in first SP among various inbreeding groups (Table 2) were statistically not significant and there was no effect of inbreeding on service period. Similarly the inbreeding depression was not significantly high to

Table 1: Distribution of Sahiwal female cattle in various inbreeding groups

Level of inbreeding coefficient (Inbreeding %)	No. of Cows	Percentage of total
Non inbreds	695	40.59
>0.0.1-3.0	526	30.73
>3.0-6.0	299	17.47
>6.0-9.0	126	7.36
>9.0 66	3.85	
Total 1712	100.00	

Table 2: Least squares analysis of variance of performance traits in different inbreeding group in Sahiwal female

Inbreeding classes (%)	AFC	CI	SP	DP
Overall	1153.95±7.37(599)	441.74±7.14 (493)	153.98±7.07(493)	116.62±5.96 (478)
Non inbreds	1124.69a±8.14 (288)	432.82±6.33 (250)	148.44±6.27 (250)	114.23±5.30 (238)
>0.0-3.0	1133.46ab±11.13 (154)	446.85±8.52 (138)	163.21±8.44 (138)	123.17±6.99 (137)
>3.0-6.0	1125.26a±16.17 (73)	425.33±13.04 (59)	143.66±12.92 (59)	121.60±10.75 (58)
>6.0-9.0	1144.80b±21.32 (42)	470.90±17.99 (31)	181.93±17.82 (31)	130.22±14.71 (31)
>9.0	1241.54c±21.32(42)	432.80±25.86 (15)	132.66±25.62 (15)	93.85±21.89 (14)

Figures in parentheses indicate number of observations. Similar superscripts indicates non-significant and dissimilar superscripts indicate significant difference among subclasses

Table 3: Least squares analysis of variance of performance in different inbreeding group in Sahiwal female

Inbreeding classes (%)	FL305MY	FLTMY	FLL	FL 305 FATY	FL 305 SNFY
Overall	1893.24±45.27(592)	2070.21±61.09(592)	323.44±6.01(592)	93.18±2.44 (482)	172.05±4.50 (482)
Non inbreds	1861.90±42.40(283)	2037.85±57.22 (283)	317.96±5.63 (283)	87.86±2.52 (198)	161.26±4.65 (198)
>0.0-3.0	1864.81±54.71 (170)	2081.22±73.83 (170)	321.01±7.26 (170)	91.09±2.78 (163)	167.50±5.13 (163)
>3.0-6.0	1891.96±81.29 (77)	2059.42±109.70 (77)	311.62±10.80 (77)	91.04±4.33 (67)	169.86±8.00 (67)
>6.0-9.0	1907.72±107.54 (44)	2101.79±145.13 (44)	321.20±14.28 (44)	95.21±5.68 (39)	176.56±10.48 (39)
>9.0	1939.83±168.14 (18)	2070.77±226.90 (18)	345.38±22.33 (18)	100.73±9.16 (15)	185.06±16.91 (15)

Figures in parentheses indicate number of observations
*** Significant (P<0.01), NS: Non significant, Figures in parentheses are number of observation.*

change the FSP and the average FCI of Sahiwal female population in various inbreeding levels.

Production traits

There was an increase in FL305MY and FLTMY in inbred animal compared to non inbred from more than 6 % level of inbreeding, however statistically not significant. Similarly regression of inbreeding on FL305MY and FLTMY were positive but not significant. The differences in FLL among various inbreeding groups (Table 3) were also statistically not significant. There was slightly decrease in LL of animal having 6% level but again increases upto more than 9 % level of inbreeding that is also statistically not significant. FL305 Fat yield and SNF yield also showing increasing trend although the difference was statistically not significant.

DISCUSSION

The mean inbreeding level of inbred Sahiwal female population was 3.7% ranging from 0.01 to 20% however, higher value 7.2±6.19% ranging from 0.11to 28.13% reported in the same population (Srinivas and Gurnani, 1979). This higher value might be because the data considered by them belongs to period when nucleus herd was in the establishing phase with small population size and the few number of proven sire and elite dam available for breeding.

However, it was reported 2.10% for Brahman cattle and 0.6 % inbreeding in Sahiwal of Kenya (Santanta *et al.* 2016; Mausya *et al.*2017). Estimates of inbreeding depend on the quality of pedigree and are therefore unique to each population. Age at first

calving was statistically significant (P≤0.01) among various inbreeding groups, whereas, other traits under study were non significant. The significance test (DMRT test) illustrated that the average AFC was statistically similar upto 6.0% level thereafter it significantly increased to 9% inbreeding level, the value was greater than non-inbreds. The regression of AFC on level of inbreeding was positive and statistically significant (P≤0.01) indicating that for an increase in inbreeding by 1 %, the increase in AFC is expected to be 18.22 days. Similarly (Corrales *et al*. 2011) observed significant effect of Inbreeding on AFC in Nicaraguan Reyna cattle 3.5 days AFC increases per unit increase of Inbreeding, where as non-significant effect of inbreeding on AFC was reported in Sahiwal cattle(Srinivas and Gurnani,1979). The inbreeding depression was not significantly high to change the FSP were as (Srinivas and Gurnani,1979) reported the regression of Inbreeding on FCI was positive but statistically not significant.

Trends with increased inbreeding was slightly high for milk yield traits among inbreds animals upto more than 9 % level of Inbreeding in FL305MY but it was statistically not significant. This increased performance in production traits might be due to selection and breeding plan in the herd. Similarly (Srinivas and Gurnani, 1979) reported in Sahiwal cattle increasing trend in first lactation milk yield and followed by gradual decline upto inbreeding coefficient of 19.9% the increase thereafter was not statistically significant. However decrease in milk yield in inbred animal compare to non inbred was reported in Sahiwal of Pakistan (Javed *et al.,* 2001) although statistically not significant ranging from 0.01 to 9.9% of inbreeding level. Similarly also reported the correlation and regression of first lactation milk yield were both positive but statistically not significant. On the basis our findings we can conclude that there is a no deleterious effect of inbreeding on most of the traits and low inbreeding level is herd indicating our herd had sufficient genetic variability and adopted successful breeding strategies to achieve the desire genetic gain. The germplasm available in the herd can be further propagated for genetic improvement and conservation of the Sahiwal in the country.

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