Frequency of monozygotes and sex ratio for twin born in Sahiwal, Karan Swiss and Karan Fries cattle

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Abstract

Present study was carried out on 18,608 calving records of both singleton and twin born occurs during 42 years from January 1969 to December 2011 in Sahiwal, Karan Swiss and Karan Fries cattle at National Dairy Research Institute, Karnal, India. Pregnancies in pure and crossbred cattle resulted from artificial insemination and natural services have been included but not by harmonal treatment or embryo transfer techniques. These calving have 143 twin births out of this six in Sahiwal, 55 in Karan Swiss and 82 in Karan Fries occurred. The sex ratio for isosexual males: heterosexual: isosexual females in Sahiwal, Karan Swiss and Karan Fries was 00**:**80**:**20, 18.60**:**46.51**:**34.88 and 36.21**:**32.76**:**31.03, respectively. The significant deviation from 1:2:1 ratio was observed in Karan Fries and, it was not found in Karan Swiss cattle. Bonnier method was used for mathematically calculating the frequency of monozygous twin in present study. The observed frequency for monozygous twin was 1.76 for all twin cases. However, only live birth considered then it was 1.8. It inferred that the frequency of monozygous twin was lower in twins born and breedwise variation was observed in the sex ratio.

Key words: Karan Fries, Karan Swiss, Monozygous, twin, Sahiwal

Introduction

Cattle are a monotocous species, which means that, under most circumstances, a successful pregnancy results in the birth of one calf. However, cattle are uniparous species and twinning occurs relatively rarely. For increasing the cattle production efforts can be done through growing the population and productivity of cattle, one of which is through the twinning in cattle. The incidence of twinning in cattle ranged from 1-10%, and influenced by genetic/breed, parity, management, season of breeding. There are genetic and non-genetic factors affecting twinning rate. Increased twin births can be done through enhanced techniques like selection, reproduction and proper management (Praharani 2019). Under some beef cattle production scenarios, twinning might be considered a desirable trait that enhances profitability by increasing weaned calf weight that is produced per cow (Cabrera and Fricke, 2021). Twinning is helpful for obtaining more progeny from a genetically superior female and can considerably increase the efficiency of production in cattle (Wakchaure and Gangly 2016). In some beef cattle systems, twinning can increase the efficiency of production by allowing for more progeny from genetically superior females (Hashiyada 2017). The major intention of dairy cattle farmers is to increase milk yield and obtain a calf in a year with regular intervals. In cattle, increasing the twinning rate is one alternative for increasing beef production but has negative effect in dairy industry. Twin pregnancies are undesirable as they seriously compromise the welfare and productive lifespan of the cow and herd economy (López-Gatius 2020). The cow factors, such as lactation number and previous twining, as well as environmental factors, such as photoperiod, season and management related to synchronization protocols affect significantly the incidence of twin pregnancies (Andreu-Vázquez et al., 2012). The problems in twinning's are the high incidence of abortion, early embryonic loss, dystocia, retained placenta, metabolic disorders, and ketosis resulting in longer calving interval. Intensive management to dam bearing twins can reduce the problems. Economically, the profits of twinning are different between beef and dairy cattle. Twin births give benefit to beef cattle farming through the increase in total weaning per cattle (Praharani 2019). Twinning is of two types: monozygotic and dizygotic. Monozygotic twins, also referred as identical twins, result from spontaneous cleavage of one fertilized oocytes during embryonic development, whereas dizygotic twins, also referred to as fraternal twins, result from fertilization of oocytes from two follicles that ovulate during the same estrous cycle. In case of twinning the sex ratio has been reported to be 1:2:1 for the Male: Male, Male: Female (heterosexual) and Female: Female twins in dizygotic twins (Hendy and Bowman 1970) however, deviation occurs in monozygous births (Silva del Rıo et al., 2007). The mathematical estimates of monozygous twinning in dairy cattle has been observed low, with estimates ranging from 7.4% (Erb and Morrison 1959) to 13.6% (Ryan and Boland 1991) of all twin births or less than 0.3% of all births. The frequency of monozygous twin was 24.7% of all twins observed in Holstein breed (Silva del Rıo et al., 2006). In cattle, the study of morphological and physiological characteristics to identify monozygotic twin has not been successful due to intensive selection and inbreeding. Identifying monozygotic (identical) twins and their percentage in livestock is crucial for understanding genetic diversity, improving breeding programs, and potentially mitigating challenges associated with twin pregnancies, like increased risks of complications during birth and for the calves. Monozygotic twins, being genetically identical, offer valuable insights into the interplay of genes and environment on traits. In view of the above facts a study was carried out to know the frequency of monozygotic twin and sex ratio for twin born calves in Sahiwal, Karan Swiss and Karan Fries breeds of cattle.

Material and Methods

Data collection

The present study was carried on data of calving includes both singleton and twin births for the period of 42 years (1969- 2011) in Sahiwal, Karan Swiss and Karan Fries cattle breeds in National Dairy Research Institute (NDRI), Karnal, India. The calving was grouped into twin and singleton born. The calving records that produced from use of harmonal treatment or embryo transfer techniques have been eliminated from the present study.

Statistical Analyses

Prior to statistical analysis, observations were checked for unlikely values. If an unlikely value was present the record was dropped. This was done separately for each analysis so as to keep as many observations as possible in the data set. Twin birth has been classified into three groups according to sex of calves for Male: Male (isosexual male), Male: Female (heterosexual) and Female: Female (isosexual female) calves.

The difference in sex ratio within breed for twin was examined as per method given by Snedecor and Cochran (1967):

$$\chi^2 = \sum[(O-E)^2 / E]$$

Where, O = Observed frequencies and E = Expected frequencies

Expected frequencies:

$$E_{ij} = \frac{(R_{i.})(C.j)}{GT}$$

Where, E_{ij} = Expected frequency belongs to i^{th} row and j^{th} column; R_i. = i^{th} row total; $C._j$ = j^{th} column total; GT = Grand total.

The frequency of monozygotic twin was estimated using a modification of Weinberg's Differential Method (Weinberg 1902). Bonnier (1946) method for calculating the frequency of monozygous twin and expressed it as a fraction of the number of like-sexed twin pairs used by (Ryan and Boland 1991; Silva del et.al., 2006) as:

$$m = \frac{2pqn - n_2}{2pq(n - n_2)}$$

Where:

m = fraction (or percentage) of the number of like-sexed twin pairs; p = observed proportion of male calf among twin birth; q = 1-p = observed proportion of female calf among twin birth; n = total number of twin pairs; n_2 = the number of unlike-sex twin pairs.

In the present study, frequency of monozygotic twin also calculated by considering live twin birth only excluding abortion and stillborn from total count of males and females, which came with live calves and these events were taken as twin births.

Results and Discussions

Sex Ratio

Sahiwal is an important dairy cattle breed of Indian subcontinent (Kumar & prasad, 2023). The distribution of 18,608 calving (1969-2011) occurred for singleton and twin in Sahiwal, Karan Swiss and Karan Fries given in Table 1. These calving have 143 twin births cases out of this six in Sahiwal, 55 in Karan Swiss and 82 in Karan Fries. The twinning rate was highest in Karan Fries (0.92%). The sex ratio for Male: Male (isosexual male), Male: Female (heterosexual) and Female: Female (isosexual female) live twin birth were 00:80:20, 18.60:46.51:34.88 and 36.21:32.76:31.03 in Sahiwal, Karan Swiss and Karan Fries, respectively. In Sahiwal no case of isosexual male occurs. The live birth sex ratio among twin shows significant deviation from 1:2:1 ratio in Karan Fries given in Table 2. The results for sex ratio in Karan Swiss (Silva del Rıo et al., 2007; Hossein-Zadeh et al., 2009) and Karan Fries (Johansson et al., 1974) has matched with earlier reports. When comparing the sex ratio of different breeds, it is probably safest to make the comparisons only within the same organization or herd for artificial insemination, milk recording and data processing because the practice of sex recording may differ somewhat between the organizations. The sex ratio 1:2:1 for the isosexual male, heterosexual twin and isosexual female occurs in dizygotic twin but deviations from this ratio have been observed in monozygotic twinning as more number of same sex calves born than expected (Hendy and Bowman 1970; Johansson et al., 1974). The biased sex ratio in calves from multiparous cows may be due to differences in the primary sex ratio or differential prenatal mortality. Alternatively, a biased sex ratio may be mediated through stress on the animal (Gosling 1986). Several studies also reported that selective prenatal mortality happens for male calves, which were born dead more frequently than female calves. This occurs most probably due to their greater demands on the mother's body, which might result in slightly earlier abortion during twin pregnancy. The present finding could be interpreted as a greater occurrence of monozygotic twins in Karan Fries cows. In support of this concept, several factors have been hypothesized to influence sex ratio, including vaginal and uterine pH (Miller et al., 2016), and maturity of the oocyte and time of timed artificial insemination (Pursley et al. 1998).

Frequency of Monozygous Twins

The frequency of monozygous twin birth was 1.76, which included all types of birth shown in Table 3. However, only live birth considered then it was 1.8% in Table 4. Contrary to the present study, Ryan and Boland (1991); Silva del Rıo et al. (2006) reported greater frequencies for monozygous twins in different breeds of cattle. These estimates inferred that there was high frequency of double ovulation (which would result in dizygous twins) in dairy cattle. Thus, monozygous twinning occurs infrequently in cattle and likely accounts for relatively few twin births in the dairy cattle. In addition, zygosity studies based on red cell antigens are not reliable in cattle because blood exchanged between conceptuses during pregnancy results in a majority of dizygotic twins with identical red cell factors. New technologies such as DNA fingerprinting and ultrasonography are better able to identify zygosity in cattle but due to absent of DNA sample we used here Bonnier mathematical equation for calculating monozygous twins frequency. In conclusion, there are genetic differences present between cattle breeds for sex ratio when twin

Table – 1: Distribution of singleton and twin calvings in Sahiwal, Karan Swiss and Karan Fries cattle

Sahiwal						Karan Swiss					Karan Fries				
Period	TCN*	TCS*	%TCS*	TCT*	%TCT*	TCN	TCS	%TCS	TCT	%TCT	TCN	TCS	%TCS	TCT	%TCT
1969-74	425	425	100.00	0	0	1503	1490	99.14	13	0.86	302	300	99.34	2	0.66
1975-80	169	168	99.41	1	0.59	2040	2031	99.56	9	0.44	926	921	99.46	5	0.54
1981-86	243	243	100.00	0	0.00	1295	1282	99.00	13	1.00	1510	1493	98.87	17	1.13
1987-92	274	273	99.64	1	0.36	928	920	99.14	8	0.86	1472	1458	99.05	14	0.95
1993-98	409	408	99.76	1	0.24	525	517	98.48	8	1.52	1572	1558	99.11	14	0.89
1999-04	674	672	99.70	2	0.30	173	173	100.00	0	0.00	1473	1457	98.91	16	1.09
2005-11	935	934	99.89	1	0.11	124	120	96.77	4	3.23	1636	1622	99.14	14	0.86
Overall	3129	3123	99.81	6	0.19	6588	6533	99.17	55	0.83	8891	8809	99.08	82	0.92

TCN* = Total calving number; TCS* = Total calving of singletons; %TCS* = Percentage of total calving of singletons; TCT* = Total calving of twins; %TCT* = Percentage of twin

Table- 2: Test of heterogeneity of sex ratio in twin born live calves in Karan Swiss and Karan Fries, 1969-2011

Types of Sex	Karan Swiss		Karan Fries	
	Observed frequency	Expected frequency	Observed frequency	Expected frequency
IM	8	10.75	21	14.5
HS	20	21.5	19	29
IF	15	10.75	18	14.5
Overall	43	Chi-square = 2.26^{NS}	58	Chi-square = 7.95*

* Significant at 5% level (P< 0.05); NS= non significant; IM = Isosexual Males; MF = Heterosexual ; FF = Isosexual Females

Table - 3: Frequency of monozygous twins born in Sahiwal, Karan Swiss and Karan Fries 1969-2011

Total twin calving*				
Breed	Sahiwal	Karan Swiss	Karan Fries	Overall
n*	6	54	83	146
n^*_2	5	27	30	63
p*	5	47	90	143
q*	7	61	76	149
m*	5.93	2	1.57	1.76

m* = fraction (or percentage) of the number of like-sexed twin pairs (monozygous to dizygous twins); p* = observed frequencies of male calf among twin birth; q* = observed frequencies of female calf among twin birth; n* = total number of twin pairs; n^*_2 = the number of unlike-sex twin pairs; Total twin Calving* = all types of twins (including aborted, stillborn)

births occur. The incidence of twinning may have both positive and negative effects, which principally depends on the drive for which the cattle are raised. Because of freemartinism, as well as management problems connected it is an undesirable trait in dairy herds. In beef cattle, however, twinning can considerably increase the efficiency of production. Low heritability, a long generation interval for progeny testing, sex-limited expression and an unfavorable correlation with milk yield make twinning difficult to control by selection. Hence, it is the type of trait for which the identification of the genetic marker - quantitative trait loci (QTL) linkage and the implementation of marker-assisted selection in breeding strategies are expected to be beneficial.

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Disclaimers/Conflict of interest

The authors hereby declare that there is no conflict of interest regarding the experimental data and manuscript.

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