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Effect of Non-genetic Factors on Udder and Teat Morphometric Traits in Sahiwal and Karan Fries Cows

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ABSTRACT

Background: The present study was designed to find out the magnitude of environmental and other non-genetic factors affecting the linear udder and teat type traits in Sahiwal and Karan Fries cows.

Methods: Total eight udder morphometric traits and seven teat morphometric traits were measured in 87 Sahiwal and 166 Karan Fries cows. The data regarding milk yield, stage of lactation, parity and season of calving for all Sahiwal and Karan Fries cows were collected.

Result: In Karan Fries cows, udder and teat type traits were significantly affected by parity and stage of lactation, while in Sahiwal cow udder and teat type traits were significantly affected by parity only. Teat circumference was significantly affected by season and stage of lactation. The results indicated that parity and stages of lactation were important sources of variation for most of linear udder and teat type traits.

Key words: Sahiwal, Teat, Type traits, Udder.

INTRODUCTION

For evaluation of cattle, emphasis has changed to objective methods such as linear type traits instead of subjective grading methods in recent years (Essien and Adesope, 2003). The type traits are body components of a cow which have an influence on milk production (Khan and Khan, 2016). Type traits are also the foundation of modern-day classification system being utilized to define dairyness of a cow (Dubey *et al*., 2014). Better type traits increase the potential of animal for dairy production (Khan and Khan, 2015). The most heavily weighted factor in Dairy Cow Unified Score Card is the udder type traits (Chu and Shi, 2002; The Holstein Association USA, Inc., 2016). The udder traits accounted 40% of the judging score card and acts as the deciding factor of the total score (Seykora and Hansen, 2000).

The environmental factors in animal production are those which are not part of the genetic make-up of an animal and not transmitted from parent to offspring (Nyamushamba *et al*., 2013). Selection within the best environment allows better gene expression and improves selection response (Missanjo *et al*., 2011). The important non-genetic factors include parity, calving year, herds, the age of cow, calving season, stage of lactation etc. as measurable effects and infectious diseases, parasitic infestations etc. as non-measurable effects. The future livestock improvement programs can be formulated using these measurable environmental effects (Javed *et al*., 2013).

A number of environmental and other non-genetic factors were reported to be affecting linear type traits (Khan and Khan, 2015). Parity was found to have significant effect on fore udder and teat type traits in Holstein-Friesian and its crosses like Karan Fries and Vrindavani cattle (Mitra *et al.*, 1998; Kuczaj, 2003; Singh *et al*., 2010; Marinov *et al*., 2015). A significant effect of parity was reported on teat length in Sahiwal cattle (Dubey, 2010, Khan and Khan, 2016; Mingoas *et al*., 2017). The stage of lactation significantly influenced dairy character and udder type traits in Bos taurus cattle and its crosses with Bos indicus (Mitra *et al.*, 1998; Marinov *et al*., 2015; Yanar *et al*., 2018). In zebu cows, significant effects of stage of lactation were observed on udder type traits (Dahiya, 2005; Khan and Khan, 2015; Khan and Khan, 2016; Mingoas *et al*., 2017). Effect of season was reported significant at classification udder type traits in Brown Swiss cows (Yanar *et al*., 2018).

Quantification of these non-genetic factors is essential for precise estimation of the linear type traits (Khan and Khan, 2015). Therefore, the present study was designed to find out the magnitude of non-genetic factors affecting the linear udder type traits in Sahiwal and Karan Fries cows.

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MATERIALS AND METHODS

Experimental animals and location of the study

The present study was conducted on lactating Sahiwal (N=87) and Karan Fries (N=166) cows maintained at Livestock Research Centre, ICAR-National Dairy Research Institute, Karnal, Haryana, India within the period of 2016-2018.

Udder and teat morphometric traits

Total eight udder morphometric traits and seven teat morphometric traits were measured on a scale varying from one biological extreme to other. The lactating Karan Fries and Sahiwal cows were summoned one hour before the routine milking and various udder and teat type traits were recorded, which included rear udder height (RUH), rear udder width (RUW), udder width (UW), fore udder attachment (FUA), udder circumference (UC), udder balance (UB), udder depth (UD), udder length (UL), fore and rear teat length (FTL and RTL), teat circumference (TC), distance between fore and rear teat (DFR), distance between right and left teat (DLR), shortest distance from fore teat end to floor (SDF), shortest distance from rear teat end to floor (SDR).

Classification of data

The collected data included animal number, breed, date of calving, stage of lactation, parity, season of calving. These data were collected from birth register and history cum pedigree sheets maintained in the Livestock record unit of Animal Genetics and Breeding Division and Livestock Research Centre, ICAR- National Dairy Research Institute, Karnal, Haryana, India.

The data on season, stage of lactation, parity and level of milk production were classified as per the variation(s) observed. On the basis of parity order, animals were divided into five parity groups: First Parity, Second Parity, Third Parity, Fourth Parity and Fifth and above. For 305 day milk production (level of milk production), the data were classified into three production groups, low producer (<1900 kg in Karan Fries; < 1000 kg in Sahiwal), medium producer (1900-4500 kg in Karan Fries; 1000-1800 kg in Sahiwal) and high producer (>4500 kg in Karan Fries; >1800 kg in Sahiwal), based on milk production (kg) in 305 days. The season of calving was classified as; April - June (summer), July - August (Rainy), September - November (autumn) and December - March (winter); on the basis of prevailing climatic conditions and fodder resources available at farm. The number of days in milk at the time of recording of the udder and teat morphometric traits was considered to define the stage of lactation for each animal. The lactation data was partitioned as early (0-3 months), mid (3-6 months) and late (9 months and above) stage.

Statistical analysis

Least squares analysis of variance for unequal and non-orthogonal data using the technique described by Harvey (1990) was used to study effect of non-genetic factors. The model was used with assumptions that different components being fitted into the model are linear, independent and additive.

RESULTS AND DISCUSSION

In Karan Fries cows, udder and teat type traits *viz.* FUA, RUH, UD, UL, UW, TC, FTL, RTL, SDF and SDR were significantly ($P<0.05$) affected by parity. Whereas, stage of lactation had significant ($P<0.05$) effect on UC, DFR and DLR (Table 1 and Table 2).

The overall least squares mean for FUA, RUH, UD, UL, UW, TC, FTL, RTL, SDF, SDR, UC, DFR and DLR are given in Table 1 and 2. RUH increased significantly with increasing parity number of the animals, Parity (>5) was found to have the highest RUH (27.08 ± 1.49 cm). UD reduced significantly from the first parity to the next onwards, Parity (>5) had the lowest UD. UL increased significantly from first parity to the next with almost similar length/no change to the next parities. UW also showed similar pattern. TC increased significantly from first parity to third parity with almost similar circumference to the next parities. FTL and RTL increased significantly from first parity to third parity with almost no change to the next parity followed by a significant increase in the fifth parity. SDF and SDR decreased significantly with increasing parity number of the animals, Parity (>5) was found to have the lowest distance from teat ends to floor.

In Sahiwal cows, udder and teat type traits *viz.* FUA, RUW, UD and UW were significantly affected by parity. Teat type trait *i.e*. TC was significantly affected by season and stage of lactation. Stage of lactation had significant effect on DFR, DLR, SDR and UC (Table 3 and Table 4). Overall least square means for FUA, RUW, UD, UW, UC, DFR, DLR, SDR and TC are given in Table 3 and 4.

FUA and UD were decreasing significantly from 1st parity to 5th parity. RUW and UW were increasing significantly from 1st to 4th parity, UW then significantly reduced from 4th to 5th parity but RUW continued to increase significantly. UC continued to decrease significantly as stage of lactation increases. TC decreased significantly from 1st to 2nd stage of lactation, afterwards continued to increase significantly. TC again reduced significantly from summer to rainy season which did not change till autumn; however a significant increase in circumference was there after autumn to winter. DFR and DLR were almost same in the first two stages of lactation which increased significantly from second to third stage of lactation (Table 3 and Table 4).

These results are in accordance with previous studies by Singh *et al*. (2010) and Dubey (2010), who reported that zebu and crossbred cattle, the mean UL, UW, UD and teat length was significantly affected by parity. Parity had significant effect on FUA, RUH, UW, UD, teat length and thickness in Holstein cattle (Marinov *et al*., 2015). The parity differences were justified because of development of udder from lactation first onward. A significant effect of parity was observed for UL, UW, UD and UC in Sahiwal cows (Khan

Table 1: Least square means for udder type traits in Karan Fries cattle.

Effects	FUA(degree)	RUH(cm)	RUW(cm)	UD(cm)	UB(cm)	UL(cm)	UW(cm)	UC(cm)
Overall (μ)	131 ± 2.02	23.67 ± 0.49	12.87 ± 0.24	53.90 ± 0.56	0.75 ± 0.53	60.34 ± 0.68	71.47 ± 0.83	142.58 ± 2.28
SEASON								
Summer (52)	120.98 ± 1.30	22.66 ± 0.83	12.98 ± 0.41	53.38 ± 0.94	2.31 ± 0.89	62.07 ± 1.14	72.01 ± 1.38	140.62 ± 3.8
Rainy (38)	118.26 ± 2.37	25.20 ± 1.12	12.96 ± 0.55	55.63 ± 1.27	-0.70 ± 1.20	59.92 ± 1.53	71.00 ± 1.86	146.49 ± 5.1
Autumn (32)	123.54 ± 3.23	23.70 ± 1.03	12.73 ± 0.50	54.38 ± 1.17	0.59 ± 1.10	60.78 ± 1.41	72.54 ± 1.72	137.92 ± 4.7
Winter (44)	119.02 ± 6.17	23.13 ± 0.90	12.82 ± 0.44	52.23 ± 1.02	0.82 ± 0.96	58.59 ± 1.23	70.34 ± 1.50	143.71 ± 4.1
PARITY								
1(57)	148.02 ± 1.62	20.99^{a} ± 0.74	11.82 ± 0.36	60.44^{d} ± 1.70	0.01 ± 0.79	54.08^{a} ± 1.01	62.54^{a} ± 1.23	139.93 ± 3.40
2(48)	132.45 ± 1.84	21.75^{a} ± 0.78	12.89 ± 0.38	55.84^{c} ± 1.20	1.11 ± 0.84	60.58^{b} ± 1.08	70.01^{b} ± 1.31	148.25 ± 3.62
3(22)	119.54 ± 1.81	24.05^{b} ± 1.17	12.94 ± 0.58	52.61^{b} ± 1.34	0.21 ± 1.26	62.00^{bc}± 1.61	73.44^{c} ± 1.96	141.17 ± 5.40
4(26)	105.36 ± 2.38	24.49^{b} ± 1.05	13.02 ± 0.52	51.67^{b} ± 1.20	2.16 ± 1.13	62.13^{bc} ± 1.44	71.18^{b} ± 1.76	144.81 ± 4.8
>5(13)	96.89 ± 2.08	27.08^{c} ± 1.49	13.69 ± 0.73	48.95^{a} ± 0.84	0.25 ± 1.60	62.92^{c} ± 2.05	80.19^{d} ± 2.49	136.76 ± 6.8
STAGE OF LACTATION								
1 (53)	119.36 ± 1.83	22.87 ± 0.97	13.15 ± 0.47	54.41 ± 1.10	0.94 ± 1.04	62.50 ± 1.33	73.82 ± 1.62	150.71^{b} ± 4.46
2 (60)	118.84 ± 2.17	23.93 ± 0.86	12.88 ± 0.42	53.49 ± 0.98	0.61 ± 0.92	59.99 ± 1.18	71.17 ± 1.44	137.51^{a} ± 3.96
3 (53)	123.15 ± 1.58	24.22 ± 0.73	12.59 ± 0.36	53.81 ± 0.83	0.69 ± 0.79	58.53 ± 1.01	69.43 ± 1.23	138.34^{a}± 3.38

Means with different superscripts in column indicates significant difference (P<0.05).

Table 2: Least squares means for teat type traits in Karan Fries cattle.

Effects	FTL(cm)	RTL(cm)	TC(cm)	DFR(cm)	DLR(cm)	SDR(cm)	SDF(cm)
Overall (μ)	5.33± 0.14	4.62 ± 0.10	7.50 ± 0.14	6.56 ± 0.36	8.86 ± 0.44	47.00 ± 0.51	46.99 ± 0.52
SEASON							
Summer (52)	5.06 ± 0.23	5.94 ± 1.34	7.75 ± 0.24	7.02 ± 0.97	8.69 ± 1.06	41.25 ± 1.19	40.37 ± 1.24
Rainy (38)	5.35 ± 0.31	6.35 ± 2.45	7.29 ± 0.33	3.00 ± 1.77	4.40 ± 1.93	44.38 ± 2.18	42.80 ± 2.26
Autumn (32)	5.33 ± 0.29	6.31 ± 3.32	7.52 ± 0.30	1.31 ± 2.41	2.19 ± 2.62	41.42 ± 2.96	40.63 ± 3.07
Winter(44)	5.58 ± 0.25	6.00 ± 1.97	7.42 ± 0.26	7.04 ± 1.43	7.94 ± 1.55	42.78 ± 1.75	41.31 ± 1.82
PARITY							
1(57)	4.47^{a} ± 0.21	3.89^{a} ± 0.15	6.52^{a} ± 0.22	5.44 ± 1.21	6.22 ± 1.31	53.53^{c} ± 0.78	53.39^{c} ± 0.77
2(48)	5.25^{b} ± 0.22	4.44^{b} ± 0.16	7.20^{b} ± 0.23	3.64 ± 1.37	4.14 ± 1.49	48.48^{d} ± 0.84	48.33^{d} ± 0.82
3(22)	5.59^{cd} ± 0.33	4.99^{c} ± 0.25	7.85^{c} ± 0.35	4.70 ± 1.35	6.37 ± 1.47	46.69^{c} ± 1.25	46.88^{c} ± 1.22
4(26)	5.48^{bc} ± 0.29	4.83^{c} ± 0.22	7.78^{c} ± 0.31	4.14 ± 1.78	5.87 ± 1.93	44.65^{b} ± 1.12	45.52^{b}± 1.09
>5(13)	5.86^{d} ±0 .42	4.95^{c} ± 0.32	8.13^{c} ± 0.44	5.06 ± 1.56	6.43 ± 1.69	41.60^{a} ± 1.59	40.89^{a} ± 1.55
STAGE OF LACTATION							
1 (53)	5.54 ± 0.27	7.11 ± 1.89	7.29 ± 0.28	3.04 ± 1.37	3.99 ± 1.48	45.07 ± 1.68	43.65 ± 1.74
2 (60)	5.16 ± 0.24	5.99 ± 2.23	7.75 ± 0.25	2.90 ± 1.62	3.43 ± 1.76	42.77 ± 1.99	41.13 ± 2.07
3 (53)	5.29 ± 0.20	5.35 ± 1.63	7.45 ± 0.21	7.83 ± 1.18	9.99 ± 1.28	39.54 ± 1.45	39.05 ± 1.50

Means with different superscripts in column indicates significant difference (P≤0.05).

Table 3: Least squares means for udder type traits in Sahiwal cattle.

Effects	FUA(degree)	RUH(cm)	RUW(cm)	UD(cm)	UB(cm)	UL(cm)	UW(cm)	UC(cm)
Overall (μ)	107 ± 2.10	22.69 ± 0.99	8.99 ± 0.32	49.37 ± 0.88	-1.83 ± 0.48	51.30 ± 0.94	63.45 ± 1.20	142.64 ± 1.80
SEASON								
Summer (52)	120.98 ± 1.30	22.80 ± 1.18	9.55 ± 0.39	47.87 ± 1.05	-1.88 ± 0.57	51.71 ± 1.13	65.21 ± 1.43	143.94 ± 2.15
Rainy (13)	118.26 ± 2.37	22.15 ± 2.15	8.28 ± 0.71	53.58 ± 1.05	-2.73 ± 1.05	49.47 ± 2.06	60.76 ± 2.61	138.65 ± 3.93
Autumn (6)	123.54 ± 3.23	22.44 ± 2.93	8.49 ± 0.97	48.11 ± 1.92	-1.10 ± 1.42	53.14 ± 2.80	64.60 ± 3.55	144.71 ± 5.33
Winter(16)	119.02 ± 6.17	23.36 ± 1.73	9.64 ± 0.57	47.90 ± 2.61	-1.63 ± 0.84	50.91 ± 1.66	63.23 ± 2.10	143.28 ± 3.16
PARITY								
1(29)	138.02^{c} ± 1.62	22.24 ± 1.47	7.85^{a} ± 0.49	53.80^{d} ± 1.31	-2.94 ± 0.71	48.33 ± 1.41	58.21^{a} ± 1.78	138.14 ± 2.68
2(22)	132.45^{d} ± 1.84	21.39 ± 1.67	8.45^{ab} ± 0.55	49.54^{b} ± 1.49	-2.41 ± 0.81	51.40 ± 1.60	61.28^{b} ± 2.02	142.08 ± 3.04
3(16)	119.54^{c} ± 1.81	23.80 ± 1.64	8.92^{b} ± 0.54	50.28^{b} ± 1.47	-1.87 ± 0.80	51.18 ± 1.57	64.97^{c} ± 1.99	145.01 ± 2.99
4(9)	105.36^{b} ± 2.38	27.04 ± 2.16	9.68^{c} ± 0.71	47.38^{a} ± 1.93	-1.53 ± 1.05	51.77 ± 2.07	68.69^{c} ± 2.62	143.91 ± 3.94
>5(11)	96.69^{a} ± 2.08	18.97 ± 1.89	10.05^{c} ± 0.62	45.82^{a} ± 1.69	-0.42 ± 0.92	53.83 ± 1.81	64.10^{d} ± 2.29	144.08 ± 3.45
STAGE OF LACTATION								
1 (40)	119.36 ± 1.84	22.59 ± 1.66	8.72 ± 0.55	49.90 ± 1.48	-2.04 ± 0.81	52.43 ± 1.59	64.76 ± 2.01	147.99^{a} ± 3.03
2 (21)	118.84 ± 2.17	21.86 ± 1.97	8.92 ± 0.65	51.72 ± 1.76	-1.75 ± 0.96	52.46 ± 1.88	62.34 ± 2.39	142.03^{b} ± 3.59
3 (26)	123.15 ± 1.58	23.60 ± 1.43	9.33 ± 0.47	46.48 ± 1.28	-1.71 ± 0.69	49.02 ± 1.37	63.26 ± 1.74	137.91^{c} ± 2.61

Means with different superscripts in column indicates significant difference (P<0.05).

Table 4: Least squares means for teat type traits in Sahiwal cattle.

Effects	FTL(cm)	RTL(cm)	TC(cm)	DFR(cm)	DLR(cm)	SDR(cm)	SDF(cm)
Overall (μ)	7.14 ± 1.00	6.15 ± 1.12	8.64 ± 0.88	4.59 ± 0.81	5.81 ± 0.88	41.28 ± 1.04	42.46 ± 1.00
SEASON							
Summer (52)	6.79 ± 1.20	4.66 ± 0.17	10.02^{b} ± 1.05	6.01 ± 0.60	8.11 ± 0.74	47.31 ± 0.86	46.43 ± 0.88
Rainy (13)	7.39 ± 2.19	4.54 ± 0.23	4.75^{a} ± 1.92	5.25 ± 0.81	8.05 ± 1.00	48.76 ± 1.16	48.84 ± 1.19
Autumn (6)	8.18 ± 2.98	4.43 ± 0.22	4.99^{a} ± 2.61	7.18 ± 0.74	9.13 ± 0.92	46.37 ± 1.07	46.76 ± 1.10
Winter(16)	6.19 ± 1.76	4.85 ± 0.19	14.81^{c} ± 1.55	7.80 ± 0.65	10.16 ± 0.81	45.56 ± 0.94	45.93 ± 0.96
PARITY							
1 (29)	5.13 ± 1.50	3.89 ± 0.15	9.12 ± 1.31	7.41 ± 0.53	9.35 ± 0.66	53.39 ± 0.77	53.53 ± 0.78
2 (22)	8.24 ± 1.70	4.44 ± 0.16	6.97 ± 1.49	6.63 ± 0.57	9.33 ± 0.71	48.33 ± 0.82	48.48 ± 0.84
3 (16)	7.82 ± 1.67	4.99 ± 0.25	9.94 ± 1.46	6.01 ± 0.85	8.14 ± 1.06	46.88 ± 1.22	46.69 ± 1.25
4 (9)	6.65 ± 2.20	4.83 ± 0.22	7.45 ± 1.93	5.96 ± 0.76	8.67 ± 0.94	45.52 ± 1.09	44.65 ± 1.12
>5 (11)	7.85 ± 1.92	4.95 ± 0.32	9.73 ± 1.69	6.81 ± 1.08	8.83 ± 1.35	40.89 ± 1.55	41.60 ± 1.59
STAGE OF LACTATION							
1 (40)	8.50 ± 1.69	7.11 ± 1.89	8.23^{b} ± 1.48	3.04^{a}± 1.37	3.99^{a}± 1.48	45.07 ± 1.68	43.65 ± 1.74
2 (21)	6.76 ± 2.00	5.99 ± 2.23	4.46^{a} ± 1.76	2.90^{a}± 1.62	3.43^{a}± 1.76	42.77 ± 1.99	41.13 ± 2.07
3 (26)	6.15 ± 1.46	5.35 ± 1.63	13.23^{c} ± 1.28	7.83^{b}± 1.18	9.99^{b}± 1.28	39.54 ± 1.45	39.05 ± 1.50

Means with different superscripts in column indicates significant difference (P<0.05).

and Khan, 2016). The significant effect of parity on TC, SDF and SDR might be due to increase in teat diameter and teat length as the parity increases (Singh *et al.,* 2010; Prasad *et al.,* 2010).

Effect of stage of lactation was seen on UC, TC, SDR, DFR and DLR in both the breeds. These findings are in agreement with Khan and Khan (2016), who revealed stage of lactation, was a significant source of variation for UC. The stage of lactation might influence all the udder and teat measurements because of effects of proceeding lactation on udder measurements and on milk yield. The increasing value SDR as parity increases, might be due to a significant effect of the stage of lactation on RUW and RUH in dairy cattle (Krastanov, 1995). The decreasing value of DFR and DLR as parity increases might be due to the effect of stage of lactation on teat position, UL, UW and UC (Angelova, 2006; Khan and Khan, 2016).

CONCLUSION

The results indicate that parity and stages of lactation were important sources of variation for most of linear udder type traits. For evaluation of Sahiwal cows, use of linear type traits obtained during first lactation will be better option to avoid parity effect biases. It will be preferable to select future bull calves from dams having linear type traits information recorded during first parity. However, for studying durability of cow for linear type traits, information on later parity cows will be required. Similarly stage of lactation effects should be kept in mind while selecting cows. In livestock improvement programs carried on linear udder type traits of Karan Fries and Sahiwal cows, the performance records of the animals have to be adjusted for the significant environmental sources of variation in order to decrease known environmental differences between animals as well as to estimate accurate breeding values.

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Conflict of interest

The authors declare that they have no conflict of interest.

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