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Studies on relationship between milk yield and skin thickness of dairy animals

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Abstract
The aim of the present investigation was to examine the relationship between skin thickness and milk yield. The experiment was conducted at Livestock Farm Complex, C.V.Sc. & A.H., ANDUAT Ayodhya, Ram Newaj Singh Dairy Farm, Kumarganj, Ayodhya (UP) and Gorakhnath Singh Dairy, Baijnathpur Gorakhpur (UP) as per availability of lactating animals (Murrah buffalo, Gir and Sahiwal cows) which was 32 animals of each breed. A total of 96 dairy animals were studied in this experiment in which 32 Murrah buffaloes, 32 Sahiwal cows and 32 Gir cows ranging from first to fourth lactation periods. The dairy animals were selected on daily milk yield and total milk yield were recorded from the records over an average period of 120 days of lactation length. The skin thickness was measured from seven sites or regions namely neck, chest, abdomen, rump, hind quarter, udder and flank of each animal. The result shows that, in Murrah buffaloes the highest average DMY was 8.16 ± 0.52, 8.62 ± 0.55, 8.29 ± 0.78, 8.15 ± 0.55, 8.69 ± 0.77 and 7.86 ± 0.39 litres by animals under thin skin thickness of neck, chest, abdomen, hind quarter, udder and flank regions respectively. In Sahiwal cows, it was observed that the highest average DMY was 7.26 ± 0.31, 7.47 ± 0.65, 7.63 ± 0.48, and 7.69 ± 0.76 litres by animals under low skin thickness of neck, chest, abdomen and udder regions respectively. Where as in Gir cows it was observed that the highest average DMY was 6.23 ± 0.46, 6.06+0.41, 5.96 ± 0.51, 5.06 ± 0.36 and 6.03 ± 0.65 litres by animals under low skin thickness of neck, abdomen, hind quarter, udder and flank regions respectively. However, it was also observed that all the Murrah buffaloes, Sahiwal and Gir cows having thick skin of different regions were found to produce lowest milk yield per day. Least square analysis showed that the relation between DMY and skin thickness of thin, moderate and thick in different regions was found to be statistically non-significant except in flank regions where different types of skin thickness found significant (p<0.01). Further it was observed TMY and type of skin thickness in different regions were not found significant (p<0.01) except udder and abdomen regions where thick skin TMY were found to be statistically highly significant (p<0.01). It may be concluded that, the udder skin thickness was minimum followed by that in ascending order in the neck, chest, abdomen, hindquarter, flank and rump regions of the animals. Further it was evident that Murrah buffalo, Sahiwal and Gir cows under their skin thickness were found to produce more milk, while moderate skin thickness produced more milk and then thick skin thickness produced milk.

Keywords: Skin thickness, murrah, sahiwal, gir, parity, milk yield

Introduction
Dairying is an important enterprise for many countries of the world. As a result it has been an important source of income generation for rural families in the developing countries. With the increase in human population, the demand for milk has also been increased (Tollens *et al*., 2004) [17]. In India, milch cattle and buffalo breeds like Sahiwal, Gir, Red Sindhi, Deoni, Murrah, Surti, Mehasana etc. Are well adapted to the prevailing environmental conditions. Among all the milch breeds, Sahiwal is considered to be one of the important cattle milch breed and thrives well in many parts of India. Animals of this breed are known for their ability of heat tolerance, disease resistance and adaptability to low input system. The average milk yield of this breed has been reported between 2,725 and 3,175 kg in a lactation period of 300 days and certain individual cows have been reported to produce as high as 4,535 kg of milk (Sastry and Thomas, 2016) [15].
In India, majority of buffalo population belong to the riverine group and the milk production is the main function of these animals. It is reported that about 73.77 % of world buffalo population are found in South Asia. In India, the total buffalo population is recorded 108.70 million and about 51% of total milk production is shared by these animals (Livestock Census, Govt. of India, 2019).

Out of 13 recognized breeds of buffalo, the Murrah breed is the most important breed that is known for its high milk yield potential. The home tract of this breed stretches around southern parts of Haryana. Average milk production in Murrah buffalo varies from 1360 to 2270 kg in a lactation period of 310 days (Sastry and Thomas, 2015) [14]. The average milk yield is reported to be 6.5 kg/day while a few individual animals yield as much as 19.1 kg/day. The extensive study on physical appearance of most of exotic cattle breeds has been carried out in various parts of the world. However, such type of information is insufficient especially the concepts of body parts measurements and milk yield relationship in dairy buffaloes is very scanty (Dhillod *et al.,* 2017) [5]. Physical features of Murrah breed such as body size, coat colour, horn shape, udder shape & size, and skin thickness are said to be related with milk production (Mondal and Pandey, 1995; Bhuiyan *et al*., 2004) [13, 3]. The skin and its appendages have many functions like protection against excessive water loss, excretion and protection against pathogens. Moreover, skin has a major importance as an organ of adjustment between the animal and its climatic environment.

The epidermis layer of skin consists of 1.5 to 2 % of the total skin thickness. It is reported that the skin thickness of buffalo is about twice that of cattle. Properties of the skin explain much of the thermo tolerance of Zebu cattle. The plane of nutrition, however, influences the thickness of adipose tissue layer. The reticular layer has increased in thickness as age advanced in Murrah buffalo as well as graded Murrah buffalo. It is generally stated that on an average large animals having soft and thin skin produce more milk and vice-versa. It has been reported that the tropical breeds of cattle generally have thinner skin than those breeds which are originated in temperate climate. The thickness of skin is an important factor to determine performance of cow (Hamid *et al.,* 2000) [8]. From early days, researchers have tried to establish a relationship between some body characteristics and milk production, so that early selection of dairy animal is possible on the basis of this relationship. Skin thickness of cattle and buffalo has been measured by various workers (Dowling 1955b; Walker, 1957; Hossain *et al.,* 2016; Barati *et al.,* 2017) [6, 18, 11, 2]. The considerable differences of result by various workers appear to be both biological and metrical in origin. However, the value of measuring cattle skin thickness and examining its relationship with other characters cannot be properly assessed unless skin thickness itself can be measured within reasonable limits of error (Hayman *et al.,* 1966) [10].

Although conflicting reports have been published regarding the relationship of skin thickness with milk production, but it is essential to study further about the skin thickness of dairy breeds. The present study has been, therefore, undertaken to investigate and determine the relationship between milk yield and skin thickness at different regions of body of dairy animals (Sahiwal, Gir cows and Murrah buffaloes).

Materials and Methods

The experiment was conducted at Livestock Farm Complex, College of Veterinary Science & Animal Husbandry ANDUAT Ayodhya, Ram Newaj Singh Dairy Farm, Kumarganj, Ayodhya (UP) and Gorakhnath Singh Dairy, Baijnathpur Gorakhpur (UP) as per availability of lactating animals (Murrah buffalo, Gir and Sahiwal cows) which was 32 animals of each breed. The dairy animals were selected on daily milk yield and total milk yield were recorded from the records over an average period of 120 days of lactation length. The skin thickness was measured from seven sites or regions namely neck, chest, abdomen, rump, hind quarter, udder and flank of each animal. The selected animals were properly tied up in order to restrict their movements for easy skin measurement. The area of skin for measurement was carefully folded and lifted up while measuring the skin fold thickness so that it may not be too much stretched and the pressure exerted at the jaws of the Digital Vernier Calipers. For getting the accurate value, all the measurements were recorded three times at bi-monthly intervals in seven regions or sites of the body in each animal. As skin thickness is double the actual thickness, therefore, it was divided by two to get actual skin thickness i.e.

$$\text{Actual skin thickness (mm)} = \frac{\text{Skin thickness measured (mm)}}{2}$$

The skin fold thickness measurements in triplicate at different locations were taken while the animals stood squarely on all four feet and head raised in a normal alert position. The procedure for measuring skin fold thickness in seven regions of animal body was as under (Barati *et al.* 2017; Dhillod *et al.,* 2017) [5, 2].

Photograph Showing Different Skin Region of Animal

1. **Neck**: At a point where two imaginary lines passing through length and width of the neck meet
2. **Chest**: Where a vertical line at the level of heart meets middle one of three lines drawn horizontally to divide one side of barrel into four horizontal compartments
3. **Abdomen:** Posterior to chest at the same level with umbilicus
4. **Hind quarter:** Parallel to haunch and about three inches the pin bones
5. **Rump**: About six inches below the front attachment of hip joint
6. **Udder**: About four inches below the rear attachment of udder
7. **Flank**: Midpoint of the triangular flank area

The data collected for skin thickness were classified into thin, moderate and thick categories based on Struge's formula (1926).

$$\frac{L-S}{1+3.322}\log_{10} n$$

Where, L= Largest value,
S = Smallest value
n = No. of observations

The milk yield recording was per day in litres.

Statistical Analysis

To see the relation between milk yield and skin thickness of different regions and correlation coefficient were done as per Snedecor and Cochran (1989) [16]. To see the effect of skin thickness of various regions of body on total milk yield and daily milk yield, Least Squares Analysis was done as per method given by Harvey (1990) [9].

The following Least Squares model was used

$Y_{ijklmnopq} = \mu + P_i + SN_j + SC_k + SA_l + SF_m + SH_n + SU_o + SR_p + e_{ijklmnopq}$

Whereas,

$Y_{ijklmnop}$ = Milk yield of t-th observation at i-th parity, j-th neck thickness, k-th chest thickness, l-th abdomen thickness, m-th flank thickness, n-th hind quarter thickness, o-th udder thickness, p-th rump thickness.

μ = overall least square mean

P_i = effect of i^{th}Parity (j=1-4

SN_j = effect of j^{th}neck thickness (k=1-3)

SC_k = effect of k^{th} chest thickness (m=1-3)

SA_l = effect of l^{th} abdomen thickness (n=1-3)

SF_m = effect of m^{th}flank thickness (r=1-3)

SH_n = effect of n^{th} hind quarter thickness (p=1-3)

SU_o = effect of o^{th}udder thickness (q=1-3)

SR_p = effect of p^{th}rump thickness (o=1-3)

$e_{ijklmnop}$ = random error ~ (μ, σ^2).

Results and Discussion

A total of 96 dairy animals were studied in this experiment in which 32 Murrah buffaloes, 32 Sahiwal cows and 32 Gir cows ranging from first to fourth lactation periods. The animals were studied in order to find a relationship between skin thickness and milk yield. The skin thickness was measured from seven sites or regions namely neck, chest, abdomen, rump, hind quarter, udder and flank of each animal. The relation between DMY (Daily Milk Yield) and skin thickness of thin, moderate and thick categories observed in Murrah buffaloes, Sahiwal and Gir cows are depicted in Table 1 and Figs. 1 to 4. In Murrah buffaloes it was observed that the highest average DMY was 8.16 ± 0.52, 8.62 ± 0.55, 8.29 ± 0.78, 8.15 ± 0.55, 8.69 ± 0.77 and 7.86 ± 0.39 litres by animals under thin skin thickness of neck, chest, abdomen, hind quarter, udder and flank regions respectively (Table 1). Further analysis showed that the highest DMY produced by buffalo cows of moderate skin thickness of rump regions were 8.59 ± 0.59 litre per day respectively.

In Sahiwal cows, it was observed that the highest average DMY was 7.26 ± 0.31, 7.47 ± 0.65, 7.63 ± 0.48, and 7.69 ± 0.76 litres by animals under low skin thickness of neck, chest, abdomen and udder regions respectively. Further analysis showed that the highest DMY produced by Sahiwal cows of moderate skin thickness of rump, hind quarter and flank regions were 7.26 ± 0.39, 7.35 ± 0.49 and 7.23 ± 0.39 litre per day respectively.

Where as in Gir cows it was observed that the highest average DMY was 6.23 ± 0.46, 6.06+0.41, 5.96 ± 0.51, 5.06 ± 0.36 and 6.03 ± 0.65 litres by animals under low skin thickness of neck, abdomen, hind quarter, udder and flank regions respectively. Further analysis showed that the highest DMY produced by Gir cows of moderate skin thickness of rump and chest regions were 6.95 ± 0.35 and 6.23 ± 0.48 litre per day respectively.

However, it was also observed that all the Murrah buffaloes, Sahiwal and Gir cows having thick skin of different regions were found to produce lowest milk yield per day. Least square analysis showed that the relation between DMY and skin thickness of thin, moderate and thick in different regions was found to be statistically non significant except in flank regions where different types of skin thickness found significant (p<0.01).

Table 1: Least squares Mean±S.E of Daily Milk Yield affected by Different skin fold thickness in Murrah, Sahiwal and Gir cows

Effect		Murrah	Sahiwal	Gir
		Mean ± S.E.	Mean ± S.E.	Mean ± S.E.
Overall mean ± S.E.		8.62 (32) ± 0.69	7.26 (32) ± 0.33	5.91 (32) ± 0.51
Stage of lactation	1st	7.92(10)^b±0.49	6.51(10)^b±0.44	4.96 (10)^b±0.26
	2nd	8.50(12)^b ±0.72	7.63 (12)^b ±0.34	5.30 (12)^b ±0.29
	3rd	8.41(10)^a ±0.62	7.56 (10)^a ±0.75	6.46 (10)^a ±0.48
Parity	1st	6.34 (8)± 0.50	5.53 (8) ± 0.41	5.63 (8) ± 0.53
	2nd	7.29 (8) ± 0.85	6.84 (8) ± 0.55	6.03 (8) ± 0.41
	3rd	7.68 (8) ± 0.55	7.16 (8) ± 0.51	6.63(8) ± 0.62
	4th	6.53 (8) ± 0.43	6.02 (8) ± 0.42	6.22 (8) ± 0.41
Neck	Thin	8.16 (10) ± 0.52	7.26 (11) ± 0.31	6.23 (10) ± 0.46
	Moderate	7.65 (11) ± 0.22	6.99 (9) ± 0.33	6.03 (10) ± 0.38
	Thick	6.03 (11) ± 0.41	6.01 (12) ± 0.44	5.63 (12) ± 0.37
Chest	Thin	8.62 (8) ± 0.55	7.47 (5) ± 0.65	5.96 (10) ± 0.41
	Moderate	7.91 (12) ± 0.49	6.42 (15) ± 0.59	6.23 (11) ± 0.48
	Thick	6.23 (12) ± 0.45	6.06 (12) ± 0.26	6.11 (11) ± 0.45
Abdomen	Thin	8.29(5) ± 0.78	7.63 (10) ± 0.48	6.06 (8) ± 0.41
	Moderate	7.11 (15) ± 0.76	7.06 (11) ± 0.41	5.56 (8) ± 0.40
	Thick	6.54 (12) ± 0.48	6.12 (11) ± 0.52	5.01 (16) ± 0.47
Rump	Thin	6.01 (10) ± 0.45	6.01 (9) ± 0.39	6.11 (9) ± 0.39
	Moderate	8.59 (9) ± 0.59	7.26 (15) ± 0.39	6.95 (9) ± 0.35
	Thick	7.82 (13) ± 0.46	7.01 (8) ± 0.41	6.25 (14) ± 0.75
HQ	Thin	8.15 (10) ± 0.55	7.26 (10) ± 0.41	5.96 (12) ± 0.51
	Moderate	7.99 (11) ± 0.45	7.35 (11) ± 0.49	5.03 (12) ± 0.59
	Thick	6.03 (11) ± 0.55	7.11 (11) ± 0.46	4.96 (8) ± 0.31
Udder	Thin	8.69 (15) ± 0.77	7.69 (5) ± 0.76	5.06 (16) ± 0.36

	Moderate	7.69 (5) ± 0.85	7.02 (15) ± 0.76	4.53 (10) ± 0.38
	Thick	6.56 (12) ± 0.40	6.36 (12) ± 0.36	4.63 (6) ± 0.41
Flank	Thin	7.86 (10)^{b} ± 0.39	7.19 (8)^{b} ± 0.30	6.03 (7)^{b} ± 0.65
	Moderate	7.01 (10)^{b} ± 0.55	7.23 (8)^{b} ± 0.39	5.26 (10)^{b} ± 0.78
	Thick	6.03 (12) ± 0.41	6.06 (16)^{a} ± 0.51	5.06 (15)^{a} ± 0.49

(Superscripts are depicted significant at $p<0.01$)

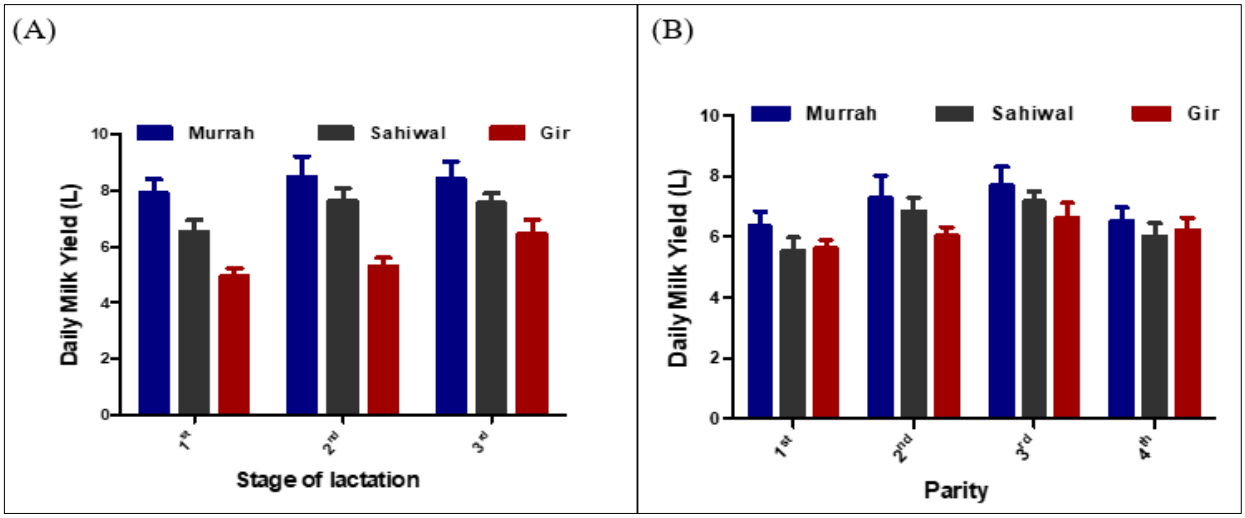

Fig 1: Daily milk yield with respect to stage of lactation and parity

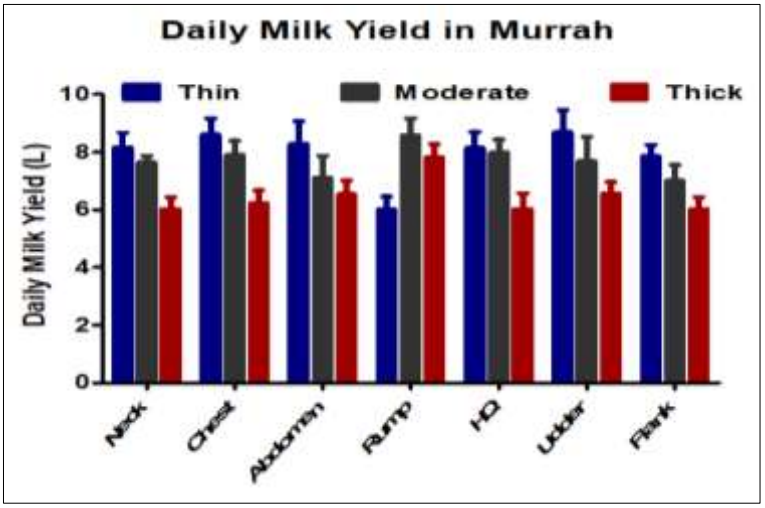

Fig 2: Daily Milk Yield affected by Different skin fold thickness in Murrah cows

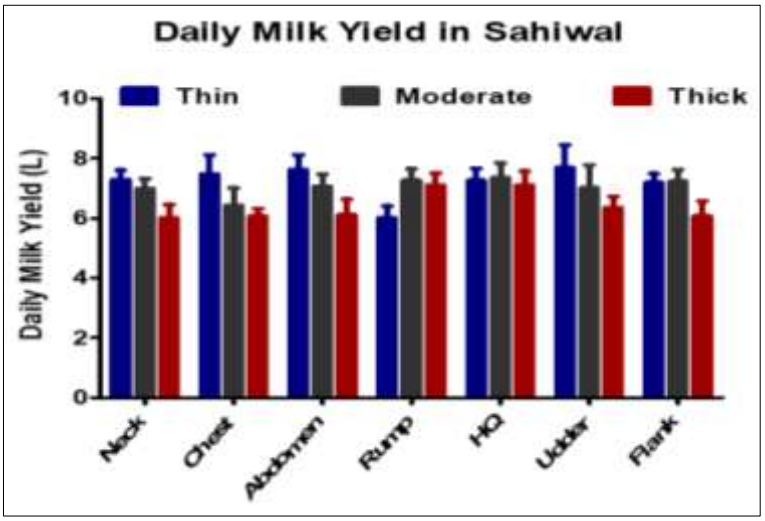

Fig 3: Daily Milk Yield affected by Different skin fold thickness in Sahiwal cows

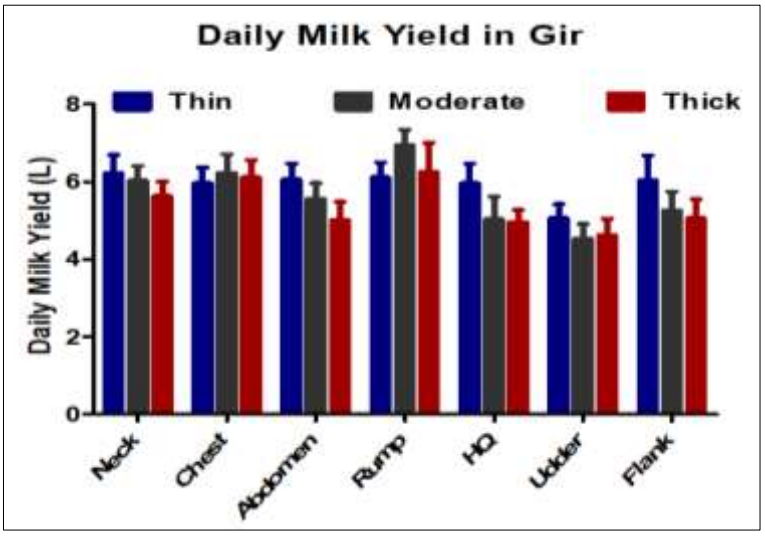

Fig 4: Daily Milk Yield affected by Different skin fold thickness in Gir cows

Least square analysis on TMY (Total Milk Yield) revealed (Table 2 and Figs. 5-8) that the highest milk yield 1599.26 ± 36.50 litres recorded in Murrah buffaloes and cows under 3rd parity followed by 1567.56 ± 35.49, 1456.51 ± 22.41, and 1453.28 ± 29.54 litres in, 2nd, 1st and 4th parity respectively. However, in further analysis it was observed that highest TMY per lactation in Murrah buffaloes was recorded under thin skin thickness of neck (1520.63 ± 30.33litres), chest (1603.58 ± 22.52), abdomen (1649.57 ± 38.92), rump (1625.82 ± 31.57), hind quarter (1602.52 ±25.99), udder (1693.54 ± 30.51) and flank (1603.00 ± 28.12). It was also observed that in Murrah Buffaloes under moderate skin thickness of abdomen, udder and chest were found to have produced total milk yield of 1603.22 ± 26.57, 1645.61 ± 28.95 and 1565.59 ± 23.59litres respectively and the production is lower than the thin skin thickness. The study also revealed that total milk yield was found to be lowest by Murrah buffalo under thick skin of (Table 2) neck (1400.62 ± 23.49 litres), flank (1496.62 ± 24.19 litres), rump (1501.62 ± 36.58 litres) and chest (1523.54 ± 24.57litres). Further it was observed TMY and type of skin thickness in different regions were not found significant (p<0.01) except udder and abdomen regions where thick skin TMY were found to be statistically highly significant (p<0.01).

The least squares analysis on TMY revealed (Table 2 and Figs. 5-8) that the highest milk yield 1599.15 ± 31.59litres recorded in Sahiwal cows under 3rd parity followed by 1532.64 ± 30.16, 1512.16 ± 25.26, and 1444.25 ± 30.64litres in 4th, 2nd and 1stparity respectively. However, further analysis observed that highest TMY per lactation by Sahiwal cows was recorded under thin skin thickness of neck (1523.52 ± 29.63 litres), chest (1526.29 ± 33.63), abdomen (1569.53 ± 28.95), rump (1601.25 ± 22.31), hind quarter (1542.63 ±35.63), udder (1599.36 ± 26.63) and flank (1532.68 ± 34.95). It was also observed that in Sahiwal cows under moderate skin thickness of udder, rump and chest were found to have produced total milk yield of 1563.52 ± 22.53, 1546.31 ±35.93 and 1516.00 ± 35.16litres respectively and the production is lower than the thin skin thickness. The study also revealed that total milk yield was found to be lowest by Sahiwal cows under thick skin of flank (1423.65 ± 22.63 litres), hind quarter (1453.62 ± 21.26 litres), neck (1456.21 ± 21.63 litres) and abdomen (1485.63 ± 23.63 litres). Further it was observed TMY and type of skin thickness in different regions were not found significant (p<0.01) except udder and ramp regions where thick skin TMY were found to be statistically highly significant (p<0.01).

The least squares analysis on TMY revealed (Table 2 and Figs. 5-8) that the highest milk yield 1399.62 ± 30.32litres recorded in Gir cows under 3rd parity followed by 1333.49 ± 31.49, 1299.32 ± 31.25, and 1245.63 ± 22.67litres in 4th, 2nd and 1stparity respectively. However, further analysis observed that highest TMY per lactation by Gir cows was recorded under thin skin thickness of neck (1362.31 ± 22.25 litres), chest (1352.64 ± 32.56), abdomen (1401.52 ± 22.53), rump (1403.25 ± 36.61), hind quarter (1356.28 ± 30.00), udder (1400.00 ± 16.52) and flank (1365.67 ± 24.93). It was also observed that in Gir cows under moderate skin thickness of chest 1362.57 ± 30.26 were found to have produced highest total milk yield and other parts of skin thickness to have produced total milk yield of udder 1354.60 ± 30.49, rump 1342.16 ± 30.26 and abdomen 1352.62 ± 36.10 litres respectively. The study also revealed that total milk yield was found to be lowest by Gir cows under thick skin of hind quarter (1263.58± 22.62 liters), neck (1264.00 ± 30.26litres), chest (1301.00 ± 29.63) and abdomen (1302.61 ± 22.16litres). Further it was observed TMY and type of skin thickness in different regions were not found significant (p<0.01) except abdomen and rump regions where thick skin TMY were found to be statistically highly significant (p<0.01).

Table 2: Least square mean ± S.E. of total milk yield affected by different skin fold thickness in Murrah, Sahiwal and Gir

		Murrah	Sahiwal	Gir
Effect		**Mean ± S.E.**	**Mean ± S.E.**	**Mean ± S.E.**
Overall mean ± S.E.		1659.02 (32) ± 25.67	1568.26 (32) ± 34.69	1358.69 (32) ± 25.95
Stage of lactation	1st	1563.84(10)^{b}±24.16	1499.32(10)^{b}±24.63	1296.31 (10)^{b}±30.32
	2nd	1695.58 (12)^{b} ±20.59	1563.67 (12)^{b} ±20.36	1395.32 (12)^{b} ±31.62
	3rd	1599.26 (10)^{a} ±21.59	1545.59(10)^{a} ±22.63	1333.20 (10)^{a} ±29.63
Parity	1st	1456.51 (8)± 22.41	1444.25 (8)± 30.64	1245.63 (8)± 22.67
	2nd	1567.56 (8) ± 35.49	1512.16 (8) ± 25.26	1299.32 (8) ± 31.25

	3rd	1599.26 (8) ± 36.50	1599.15 (8) ± 31.59	1399.62 (8) ± 30.32
	4th	1453.28 (8) ± 29.54	1532.64 (8) ± 30.16	1333.49 (8) ± 31.99
Neck	Thin	1520.63 (10) ± 30.33	1523.52 (11) ± 29.63	1362.31 (10) ±22.25
	Moderate	1459.67 (11) ± 38.59	1503.78 (9) ± 25.61	1321.46 (10) ± 21.63
	Thick	1400.62 (11) ± 23.49	1456.21 (12) ± 21.63	1264.00 (12) ± 30.26
Chest	Thin	1603.58 (8) ± 22.52	1526.29 (5) ± 33.63	1352.64 (10) ± 32.56
	Moderate	1565.59 (12) ± 23.59	1516.00 (15) ± 35.16	1362.57 (11) ± 30.26
	Thick	1523.54 (12) ± 24.57	1501.62 (12) ± 27.93	1301.00 (11) ± 29.63
Abdomen	Thin	1649.57 (5) ± 38.92	1569.53 (10) ± 28.95	1401.52 (8) ± 22.53
	Moderate	1603.22 (15) ± 26.57	1501.52 (11) ± 30.26	1352.62 (8) ± 36.10
	Thick	1585.95 (12) ± 30.49	1485.63 (11) ± 23.63	1302.61 (16) ± 22.16
Rump	Thin	1625.82 (10) ± 31.57	1601.25 (9) ± 22.31	1403.25 (9) ± 36.61
	Moderate	1569.76 (9) ± 26.64	1546.31 (15) ± 35.93	1342.16 (9) ± 30.26
	Thick	1501.62 (13) ± 36.58	1522.32 (8) ± 22.63	1324.63 (14) ± 31.26
HQ	Thin	1602.52 (10) ± 25.99	1542.63 (10) ± 35.63	1356.28 (12) ± 30.00
	Moderate	1558.59 (11) ± 27.59	1501.36 (11) ± 26.49	1326.85 (12) ± 24.62
	Thick	1555.47 (11) ± 31.19	1453.62 (11) ± 21.26	1263.58 (8) ± 22.16
Udder	Thin	1693.54 (15) ± 30.51	1599.36 (5) ± 26.63	1400.00 (16) ± 16.52
	Moderate	1645.61 (5) ± 28.95	1563.52 (15) ± 22.53	1354.60 (10) ± 30.49
	Thick	1600.51 (12) ± 27.49	1502.31 (12) ± 33.26	1299.64 (6) ± 26.48
Flank	Thin	1603.00 (10)[b] ± 28.12	1532.68 (8)[b] ± 34.95	1365.67 (7)[b] ± 24.93
	Moderate	1506.25 (10)[b] ± 22.67	1456.36 (8)[b] ± 21.49	1326.21 (10)[b] ± 22.42
	Thick	1496.62 (12)[a] ± 24.19	1423.65 (16)[a] ± 22.63	1363.00 (15)[a] ± 30.21

(Superscripts are depicted significant at $p<0.01$)

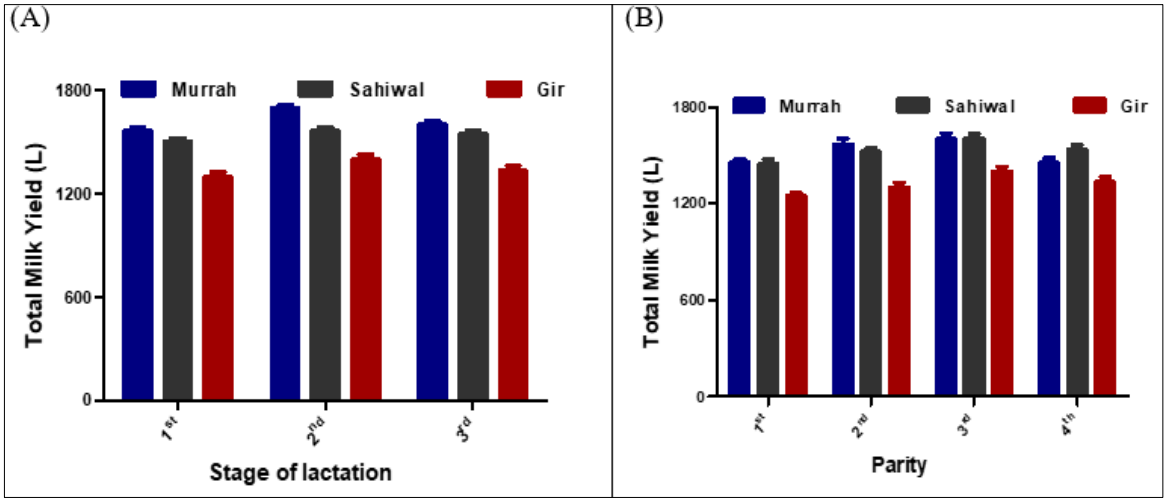

Fig 5: Total milk yield with respect to stage of lactation and parity

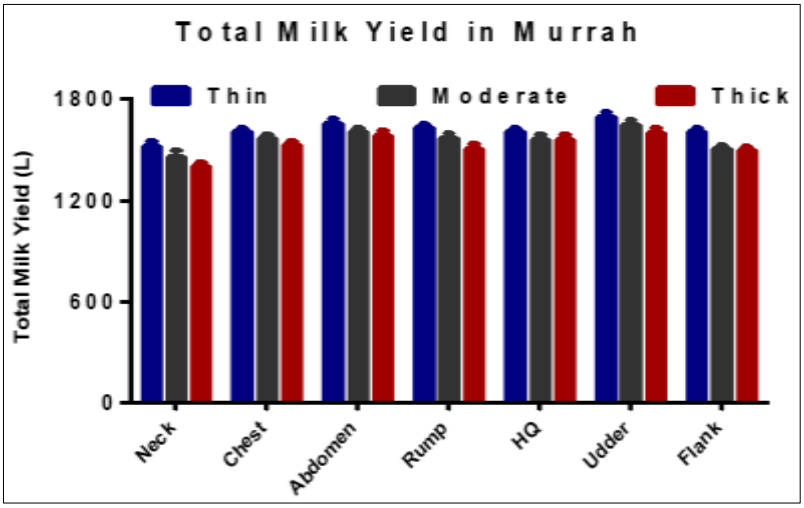

Fig 6: Total milk yield affected by different skin fold thickness in Murrah

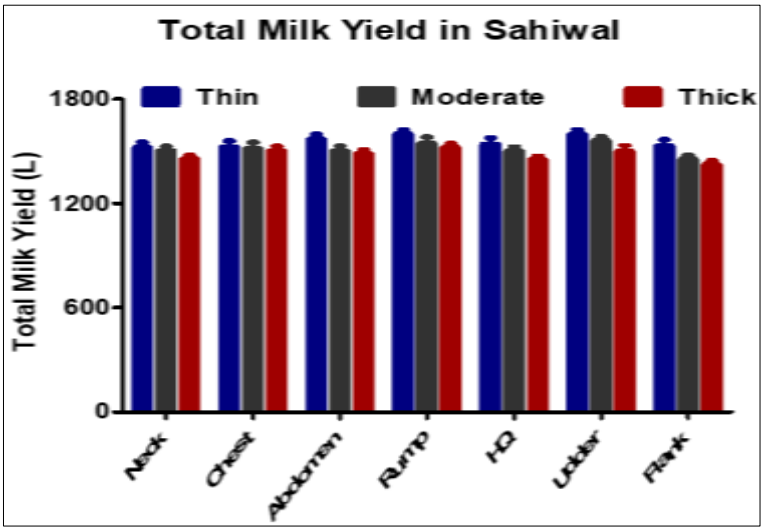

Fig 7: Total milk yield affected by different skin fold thickness in Sahiwal

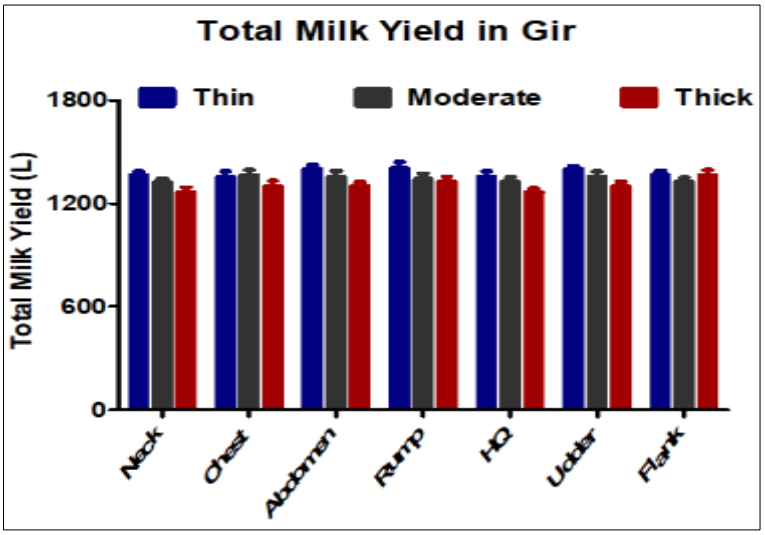

Fig 8: Total milk yield affected by different skin fold thickness in Gir

The present study is corroborated with the earlier workers (Barati *et al.*, 2017) [2] where they found that the flank and udder region having thin skin fold yielded significantly ($p<0.01$) greater milk than thick skinned animals and the neck region with moderate thickness of skin produced significantly ($p<0.01$) more milk. Finzi and Cenni (1962) [7] also observed animals with thin and pliable skin associated with higher skin production. Bharadraj *et al.* (2007) [1] found higher milk yield in buffaloes having thin skin than medium and thick skinned animals. Animals with thin skin could dissipate more heat and thus be more efficient for the production of milk in warm regions. Desai and Sharma (1962) [4] also reported positive and significant correlation of skin thickness and milk yield in Haryana cattle.

Conclusion

From the findings of the present study, it may be concluded that, the udder skin thickness was minimum followed by that in ascending order in the neck, chest, abdomen, hindquarter, flank and rump regions of the animals. Further it was evident that Murrah buffalo, Sahiwal and Gir cows under their skin thickness were found to produce more milk, while moderate skin thickness produced more milk and then thick skin thickness produced milk.

References

1. Bharadwaj A, Dixit VB, Sethi RK, Khanna S. Association of breed characteristics with milk production in Murrah buffaloes. Indian J Anim. Sci 2007;77(10):1011-1016.
2. Barati R, Singh R, Fahim A, Singh YP, Ali N, Gupta A *et al*. Skin measurements in relation to milking traits in Murrah buffaloes. Indian J Anim. Sci 2017;87(10):1282-1284.
3. Bhuiyan MM, Islam MR, Ali MC, Hossain MK, Kadir MK, Lucky NS *et al*. Importance of mammary system conformation traits in selecting dairy cows on milk yield in Bangladesh. J Biol. Sci 2004;4(2):100-102.
4. Desai RN, Sharma MD. Predicting body weight from measurements in Hariana cattle. Indian Vet. J 1962;39:72-72.
5. Dhillod S, Kar D, Patil CS, Sahu S, Singh N. Study of the dairy characters of lactating Murrah buffaloes on the basis of body parts measurements. Vet. World 2017;10(1):17-21.
6. Dowling DF. The thickness of cattle skin. Aust. J Agric. Res 1955b;6:776-785.
7. Finzi A, Cenni B. Skin thickness in relation to milk production in bovines. Revista Zootecnia 1962;35:152.

8. Hamid MA, Hussain SMI, Khan MKI, Islam MN, Biswas MAA. Skin thickness in relation to milk production of crossbred cows. Pak. J Biol. Sci 2000;3(9):1525-1529.
9. Harvey WR. Guide for LSMLMW, PC-1 version mixed model least squares maximum livelihood computer programme. Mimeograph Ohio State Uni. USA 1990.
10. Hayman KH, Beeston JWU, Allen TE, Nay T. Skin thickness in Sahiwal and Jersey cattle and its measurements. J Agric. Sci 1966;67:345-351.
11. Hossain ME, Uddin M, Shil SK, Kabir MHB, Mahmud MS, Islam KN. Histomorphometrical characterization of skin of native cattle (*Bos indicus*) in Bangladesh. Am. J Med. Biol. Res 2016;4(3):53-65.
12. Livestock Census. 19th livestock census. Ministry of Agriculture, Department of Animal Husbandry Dairying and Fisheries. Government of India 2012.
13. Mondal PK, Pandey UK. Factors influencing the market price of dry pregnant Murrah buffaloes in Haryana. Indian J Dairy Sci 1995;48:12-17.
14. Sastry NSR, Thomas CK. Breeds of livestock. Livestock Production Management. Kalyani Publishers, New Delhi, India 2015, 74.
15. Sastry NSR, Thomas CK. (Reprint). Livestock Production Management Fifth Edition 2016, 62-65.
16. Snedecor GW, Cochran WG. Statistical Methods. 8th edn. The Iowa State University Press, Ames, Iowa, USA 1989.
17. Tollens E, Matty D, Swennen R. Agrobiotechnology in developing countries- North-South partnerships are the key. Outlook Agric 2004;33:231-238.
18. Walker CA. The skin thickness of cattle in Northern Rhodesia. J Agric. Sci 1957;49(2):211-213.