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Effect of skin fold thickness in different region on milk production in Murrah buffaloes

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Abstract
The experiment was conducted with the duration of six months at ABIS (Aamir Bahadur Sultan Ali) Buffalo Dairy Farm, Gormara, Rajnandgaon (Chhattisgarh) to investigate the variability of skin thickness in relation to milk production. A total of 120 milking Murrah buffaloes were selected for the experiment. The Murrah buffaloes were selected in a range of first to sixth parity and each parity containing 20 buffaloes. All the selected Murrah buffaloes of the present investigation were kept under similar housing system i.e. loose housing system with one shelter along one side of the paddock and provided green fodder and total mix ration as per their requirement. The milking was done by milking machine in milk parlour in morning and evening. Daily milk yield and total milk yield were recorded from the records. The highest average daily milk production was 7.61 ± 0.42, 7.14 ± 0.41, 7.30 ± 0.33 and 7.56 ± 0.37 litres by cows under low skin thickness of chest, hind quarter, udder and flank regions respectively. It was also observed that cows under moderate skin thickness of abdomen and udder were found to have produced highest total milk yield of 1558.05 ± 44.05 and 1562.00 ± 34.42 litres respectively. On contemporary, total milk yield was found to be lowest by cows under thick skin of hind quarter (1511.53 ± 35.04 litres), rump (1483.12 ± 42.89 litres), abdomen (1519.89 ± 35.30 litres) and neck (1398.91 ± 44.49 litres).

Keywords: Skin thickness, daily milk yields, total milk yields, lactation length

Introduction
Buffaloes play a very crucial role in Indian agriculture. They are reared for the milk production, to generate the income of people of rural areas of developing countries. In Asia contribute about 73.77% of world buffalo population. In India, the total buffalo population is 109.20 million and about 53% of total milk production is shared by these animals (Livestock census, 2019) [1]. Milk yield is an important selection criterion in buffalo breeding programme. Some morphological features like body length, chest girth, abdominal girth, body depth, hip bone distance, pin bone distance, height at wither, muzzle width, tail length, udder dimension and skin thickness are considered important for selection of dairy buffaloes. Physical features of Murrah breed such as body size, coat colour, horn shape, udder shape and size, and skin thickness are said to be related with milk production (Mondal and Pandey, 1995; Bhuiyan *et al.*, 2004) [2, 3]. One of the important traits, skin thickness may be associated with selection and judging of dairy buffaloes for their economic character (Barati *et al.*, 2017) [4].
It is generally stated that on an average large animal 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) [5]. Cattle with lighter and thinner coats were found to yield more milk than thick coat animals. Higher milk yield in thinner coat animals may be partly due to their better ability to evaporate and to tolerate heat stress leading to minimum effect on milk production (Prabhakar *et al.*, 2018) [6]. The objective of this study was to see effect of skin fold thickness in different region on milk yields in Murrah buffaloes.

Materials and Methods: The experiment was conducted in total on 120 Murrah buffaloes on basis of parity ranges from 1st to 6th at ABIS (Aamir Bahadur Sultan Ali) Buffalo Dairy Farm, Gormara, Rajnandgaon (Chhattisgarh) to investigate the variability of skin thickness in relation to milk production.

Each parity having 20 Murrah buffaloes for the experiment. Daily milk yield and total milk yield were recorded from the records over a period of 305 days lactation period.

Measuring skin thickness of Murrah buffalo

The selected animals were properly tied up in order to neck, restrict their movements for easy skin measurements. The area of skin for measurement was carefully folded and lifted up while measuring the skin fold thickness so that it may not to 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 different intervals in seven regions of the body in each buffalo. As skin thickness was double the actual thickness, therefore, it was divided by two from such skin fold thickness measurements so as to get actual skin thickness i.e.

$$\text{Skin thickness in mm} = \frac{\text{Skin thickness}}{2}$$

The skin fold thickness measurements 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 or sites of animal body plates was as under (Dowling, 1964; Barati *et. al.* 2017; Dhillod *et al.*, 2017) [7, 4, 8].

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) [9]:

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

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

Statistical analysis: the relation between milk yield and skin thickness of different regions were analyzed done as per Snedecor and Cochran (1989) [10].

Results and Discussion

Milk yield: The mean Daily Milk Yield (DMY) of Murrah buffalo cows recorded 7.08 ± 0.27 liter per day (Table 1) in 258.06 ± 5.55 days of lactation length (Table.3). The DMY was 5.87 ± 0.54, 7.13 ± 0.49 and 7.78 ± 0.63 liters in 1st, 2nd and 3rd lactation periods respectively. However, further data showed that DMY in 4th lactation period was 7.31 ± 0.49 litres per day, while it was 6.96 ± 0.45 and 7.41 ± 0.53 litres in 5th and 6th lactation periods respectively. DMY was found to be statistically significant (P<0.01) in different stages of lactations.

The similar pattern was observed (Table 2) on Total Milk Yield (TMY) where it was observed 1305.73 ± 51.96, 1674.90 ± 47.11 and 1853.09 ± 60.60 litres in 1st, 2nd and 3rd lactation periods. The TMY was decreased during 5th (1316.01 ± 42.96) and 6th (1033.62 ± 50.76) lactation periods. It was also observed that total milk yield was observed to be significant (P<0.01) in different lactation periods. However, it was found non-significant (P<0.01) in different stages of lactations.

The further analysis (Table 3) revealed that mean Lactation Length (LL) recorded 258.06 ± 5.55 days. Least square analysis showed that the lactation length varied from 251.99 ± 11.12 days (1st lactation) to 271.02 ± 10.12 days (4th lactation period). Subsequently it was decreased in 5th lactation period (257.52 ± 9.91 days). However, it was found statistically non-significant (p<0.01) between the different lactation periods and lactation length.

The average DMY and TMY by Murrah buffalo cows over a period of different lactations were observed variation in different studies. Kamble *et al* (2014) [11] reported that the highest milk yield (1257.15 ± 29.55 litre) and daily peak milk yield was observed among buffaloes calved during winter seasons. Dhillod *et al.* (2017) [8] reported an average 2604.8 ± 39.5 kg milk yield in 305 days in Murrah buffalo. Gradual increase in milk yield from 1st to 4th lactations in cows was reported by Mudgal *et al*. (1990) [12]. However, Chowdary and Barhat (1979) [13] observed that milk yield for Zebu cattle were gradually increased from 1st to 3rd lactations. The present study indicated that total milk yield by Murrah buffalo cows was highest in 4th lactation followed by 3rd,2nd and 5th lactation periods. However, the average daily milk yield was found to be highest during 4th lactation period in the present study. The gradual increase of milk production towards upward lactation order may be due to the fact that in the early lactation all the Murrah buffalo cows are not only in production stage but also in growing stage and both with the processes lead to drain of energy reserve of the body. The other reason might be the culling of inferior producers in earlier lactation.

Milk yield and skin thickness: The relation between DMY and skin thickness of thin, moderate and thick categories observed in Murrah buffalo cows are shown in Table 1. It was observed that the highest average DMY was 7.61 ± 0.42, 7.14 ± 0.41, 7.30 ± 0.33 and 7.56 ± 0.37 litres by animals under low skin thickness of chest, hind quarter, udder and flank regions respectively. Further analysis showed that the highest DMY produced by buffalo cows of moderate skin thickness of neck, abdomen and rump regions were 7.45 ± 0.38, 7.45 ± 0.46 and 7.48 ± 0.36 litres per day respectively. However, it was also observed that all the Murrah buffalo 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 (P<0.01) 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 (DMY) affected by different skin fold thickness in Murrah buffaloes.

Effect		Mean ± S.E.
Overall mean ± S.E.		7.08 (120) ± 0.27
Stage of lactation	1st	7.49(15)^{b}±0.57
	2nd	7.70(86)^{b} ±0.22
	3rd	6.03(19)^{a} ±0.46
Parity	1st	5.87 (20) ^{NS} ± 0.54
	2nd	7.13 (20) ^{NS} ± 0.49
	3rd	7.78 (20) ^{NS} ± 0.63
	4th	7.31 (20) ^{NS} ± 0.49
	5th	6.96 (20) ^{NS} ± 0.45
	6th	7.41 (20) ^{NS} ± 0.53
Neck	Thin	7.15 (50) ^{NS} ± 0.36
	Moderate	7.45 (33) ^{NS} ± 0.38
	Thick	6.63 (37) ^{NS} ± 0.47
Chest	Thin	7.61 (36) ^{NS} ± 0.42
	Moderate	6.98 (35) ^{NS} ± 0.39
	Thick	6.64 (49) ^{NS} ± 0.44
Abdomen	Thin	6.79 (39) ^{NS} ± 0.44
	Moderate	7.45 (31) ^{NS} ± 0.46
	Thick	6.99 (50) ^{NS} ± 0.37
Rump	Thin	6.64 (49) ^{NS} ± 0.33
	Moderate	7.48 (39) ^{NS} ± 0.36
	Thick	7.11 (32) ^{NS} ± 0.45
HQ	Thin	7.14 (38) ^{NS} ± 0.41
	Moderate	7.05 (32) ^{NS} ± 0.39
	Thick	7.03 (50) ^{NS} ± 0.36
Udder	Thin	7.30 (46) ^{NS} ± 0.33
	Moderate	7.10 (45) ^{NS} ± 0.36
	Thick	6.83 (29) ^{NS} ± 0.46
Flank	Thin	7.56 (47) ^{b} ± 0.37
	Moderate	7.39 (40) ^{b} ± 0.38
	Thick	6.28 (33) ^{a} ± 0.40

(Superscripts are depicted significant at $P<0.01$)
NS = Non-Significant

Least square analysis on TMY revealed (Table 2) that the highest milk yield (2064.16 ± 47.28 litres) recorded in Murrah buffalo cows under 4th lactation period followed by 1853.09 ± 60.60, 1674.90 ± 47.11, 1316 ± 42.96, 1305.73 ± 51.96 and 1033.62 ± 50.76 litres in 3rd, 2nd, 5th, 1st and 6th lactation periods respectively.

Table 2: Least Square mean ± S.E. of Total Milk Yield (TMY) affected by different skin fold thickness in Murrah buffaloes

Effect		Mean ± S.E.
Overall mean ± S.E.		1541.25 (120) ±25.96
Stage of lactation	1st	1530.29 (15) ^{NS}± 54.65
	2nd	1525.66 (86) ^{NS} ±20.89
	3rd	1567.80(19) ^{NS}±44.07
Parity	1st	1305.73 (20)^{b}± 51.96
	2nd	1674.90 (20)^{c}± 47.11
	3rd	1853.09 (20)^{d}± 60.60
	4th	2064.16 (20)^{e}± 47.28
	5th	1316.01 (20)^{b}± 42.96
	6th	1033.62 (20)^{a}± 50.76
Neck	Thin	1684.04 (50)^{c}±34.14
	Moderate	1540.80 (33)^{b}±36.01
	Thick	1398.91 (37)^{a}± 44.69
Chest	Thin	1629.83 (36)^{c}± 40.72
	Moderate	1474.90 (35)^{b}± 37.35
	Thick	1519.03 (46)^{a}± 42.54
Abdomen	Thin	1545.81 (39) ^{NS}± 42.24
	Moderate	1558.05 (31) ^{NS}± 44.05
	Thick	1519.89 (50) ^{NS}±35.30
Rump	Thin	1601.64 (49) ^{NS}± 32.09
	Moderate	1539.00 (39) ^{NS}± 34.78
	Thick	1483.12 (32) ^{NS} ± 42.89
Hind quarter	Thin	1571.62 (38) ^{NS}± 39.15

	Moderate	1540.60 (32) ^{NS}± 36.97
	Thick	1511.53 (50) ^{NS}± 35.04
Udder	Thin	1528.48 (46) ^{NS}± 31.61
	Moderate	1562.00 (45) ^{NS}± 34.42
	Thick	1533.27 (29) ^{NS}± 43.86
Flank	Thin	1507.30 (47) ^{NS}± 35.84
	Moderate	1555.82 (40) ^{NS}± 36.70
	Thick	1560.63 (33) ^{NS}± 38.70

(Superscripts are depicted significant at $P<0.01$)
NS = Non-Significant

However, further analysis observed that highest TMY per lactation by cows was recorded under thin skin thickness of neck (1684.04 ± 34.14litres), chest (1629.83 ± 40.72), rump (1601.64 ± 32.09 litres) and hind quarter (1571.62 ± 39.15 litres). It was also observed that cows under moderate skin thickness of abdomen and udder were found to have produced highest total milk yield of 1558.05 ± 44.05 and 1562.00 ± 34.42 litres respectively.

The study also revealed that total milk yield was found to be lowest by cows under thick skin of hind quarter (Table 2) (1511.53 ± 35.04 litres), rump (1483.12 ± 42.89 litres), abdomen (1519.89 ± 35.30 litres) and neck (1398.91 ± 44.49 litres). Further it was observed TMY and type of skin thickness in different regions were not found significant ($P<0.01$) except neck and chest regions where thick skin TMY were found to be statistically highly significant ($P<0.01$).

Least square analysis (Table 3) revealed that highest lactation length recorded in animals under 4th lactation (271.02 ± 10.12 days) followed by 2nd lactation (267.60 ± 10.08 days), 6th lactation (261.34 ± 10.86days), 5th lactation(2572 ± 9.19 days), 1st lactation (251.99 ± 11.12 days) and 3rd lactation periods (238.90 ± 12.97days). Highest lactation length in cows under thin skin thickness was found in neck (264.52 ± 7.31 days) and flank regions (263.43 ± 7.67 days), while it was recorded in cows having moderate skin thickness in the regions of udder (261.57 ± 6.76 days) and chest (261.83 ± 7.99 days). However, further analysis showed that cows with thin skin thickness recorded highest lactation length in abdomen (266.50 ± 7.55 days) followed by rump (262.44 ± 9.18 days) and hind quarter (268.16 ± 7.50 days).

Bharadwaj *et al*. (2007) [14] indicated that the milk yield was significantly higher in buffaloes having thin skin (2184 ± 38 kg) than medium (1973 ± 35kg) and thick skin buffaloes (1848 ± 47kg).

Barati *et al.* (2017) [4] reported that the neck and chest regions with moderate thickness of skin in Murrah buffalo significantly ($P<0.01$) produced 6.67 ±0.29 and 6.40±0.14 kg per day respectively. The udder and flank regions with thin skin yielded significantly more milk than thick skin animals. The values were 5.49±0.42 kg/day (udder) and 8.37± 0.42 kg/day (flank). The authors also observed that animals having thick and moderately thick skin in abdomen produced significantly ($P<0.01$) more milk (6.72±0.27 kg/day). Further it was reported that the daily milk yield has negative significant correlations with skin fold thickness of flank (-0.334) and udder (-0.264) regions. However, the daily milk yield was negative correlated with skin fold thickness of neck (-0.103), chest (-0.111) and abdomen (-0.051). The authors concluded that animals having thin and moderately thick skin were observed to yield higher amounts of milk with a greater flow rate compared to thick skinned animals.

Table 3: Least squares mean ± S.E. of Lactation Length (LL) affected by different skin fold thickness in Murrah buffaloes

Effect		**Mean ± S.E.**
Overall mean ± S.E.		258.06(120) ± 5.55
Stage of lactation	1st	158.40(15)^{a} ± 11.69
	2nd	253.46(86)^{b} ± 4.47
	3rd	362.33(19)^{c} ± 9.43
Parity	1st	251.99 (20) ^{NS} ±11.12
	2nd	267.60 (20) ^{NS} ± 10.08
	3rd	238.90 (20) ^{NS} ± 12.97
	4th	271.02 (20) ^{NS} ± 10.12
	5th	257.52 (20) ^{NS} ± 9.19
	6th	261.34 (20) ^{NS}±10.86
Neck	Thin	264.52 (50) ^{NS} ±7.31
	Moderate	252.13 (33) ^{NS} ±7.71
	Thick	257.54 (37) ^{NS} ± 9.56
Chest	Thin	259.98 (36) ^{NS} ±8.71
	Moderate	261.83 (35) ^{NS} ±7.99
	Thick	252.38 (49) ^{NS} ± 9.10
Abdomen	Thin	260.07 (39) ^{NS} ± 9.04
	Moderate	247.62 (31) ^{NS} ± 9.43
	Thick	266.50 (50) ^{NS} ± 7.55
Rump	Thin	260.02 (49) ^{NS} ± 6.87
	Moderate	251.72 (39) ^{NS} ±7.44
	Thick	262.44 (32) ^{NS} ± 9.18
Hind quarter	Thin	249.37 (38) ^{NS} ± 8.38
	Moderate	256.66 (32) ^{NS} ±7.91
	Thick	268.16 (50) ^{NS} ±7.50
Udder	Thin	259.99 (46) ^{NS} ± 6.76
	Moderate	261.57 (45) ^{NS} ± 7.36
	Thick	252.63 (29) ^{NS} ± 9.39
Flank	Thin	263.43 (47) ^{NS}± 7.67
	Moderate	258.72 (40) ^{NS}±7.85
	Thick	252.04 (33) ^{NS} ±8.28

(Superscripts are depicted significant at $P<0.01$)
NS = Non-Significant

From the above findings it is evident that there was no uniform pattern of daily milk yield and total milk yield observed in Murrah buffalo cows under different categories of skin thickness. However, the low skin thickness of chest, hind quarter, udder and flank and moderate skin thickness of neck, abdomen and rump were found to be highest average milk producing animals.

It was also observed that highest total milk yield was recorded in cows under low skin thickness of neck, chest, rump and hind quarter, moderate skin thickness of abdomen and udder and thick skin of flank regions. More milk yield from thick skin of flank region may be due to under- skin fat deposits in the animals.

All the lactating animals under thick skin at different region were found to be lowest milk producing animals. This might be the fact that animals under thin and moderate skin thickness did not deposit extra fat in their body and utilized most of their energy for milk production. On the other hand

thick skin thickness Murrah buffalo cows probably might have deposited fat in their body and did not convert all their intake energy for milk production.

The present study is corroborated with the earlier workers (Barati *et al.*, 2017) [4] 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) [15] also observed animals with thin and pliable skin associated with higher skin production. Bharadraj *et al*. (2007) [14] 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) [16] also reported positive and significant correlation of skin thickness and milk yield in Haryana cattle.

Conclusion: it concluded that the Murrah buffalo cows under thin skin thickness of chest, hind quarter, udder and flank were found to produce more milk while moderate skin thickness of neck, abdomen and rump produced more milk. However, their skin of all sites of body under study recorded lowest daily milk yield. The skin thickness of all sites was found to decrease in animals proceeded from 2nd to 3rd lactation periods.

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