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Research Article

Performance Traits and Milk Composition of Different Cattle Breeds Reared under Subtropical Conditions of Khyber Pakhtunkhwa Pakistan.

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ABSTRACT

The present study was conducted to investigate the comparative adaptability of different exotic cattle breeds in subtropical conditions. For these purposes, the performance characteristics of three different cattle breeds, including Holstein Friesian (HF), Australian Friesian (AF), and Jersey, reared at Livestock Research & Breeding Farm, The University of Agriculture, Peshawar, were studied. Data from 2010 to 2020 were utilized. Results showed that a significantly higher daily milk yield (DMY), peak milk yield (PMY), and lactation yield (LY) were recorded for the HF breed than for AF and Jersey. The significantly highest DMY, PMY, and LY were recorded in the fifth parity. A significantly higher fat content was found in the milk of the Jersey breed as compared to HF and AF breeds. Protein and solid non-fat (SNF) were significantly higher in the HF breed than in the AF and Jersey breeds. The DMY and the SMY were significantly correlated with PMY, but a negative, insignificant Pearson correlation was found between Lactose, Total Solids, and pH; however, protein and SNF showed a positive Pearson correlation. The highest production performance was observed in the HF breed, indicating its better productive performance under the prevailing management and climatic conditions. Therefore, the HF breed of cattle should be raised for future breeding, according to the study's current findings.

Keywords: Livestock, milk production, parity, traits, Holstein Friesian, Australian Friesian.

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INTRODUCTION

Pakistan is blessed with an abundance of cattle, with 1 million animals: 33.0% cattle, 29.9% buffaloes, 27.4% sheep, and 58.3% goats. Animal productivity in Pakistan is typically low, and it needs to increase (Government of Pakistan, 2010). Furthermore, the cattle business employs about 8 million employees directly and indirectly. Cattle (53.4 million heads) and buffalo (43.7 million heads) make up Pakistan's livestock

population, and if their export potential is identified and assessed, it could alter the local dairy industry and have a significant impact on the national economy (Pakistan Economic Survey 2021-2022).

In Pakistan, about 70% of the cattle population is non-descript, and these animals mature slowly and produce insufficient milk. Early in the 1970s, a cross-breeding effort with exotic temperate breeds was initiated by importing frozen semen from Jersey and Friesian ls to increase their reproductive and productive capacity. To guarantee a dependable and abundant supply of semen for cross-breeding, a herd of eighty-six mature, pregnant Holstein-Friesian cows was brought from the USA in 1985 (Haq et al., 1993). Rehman et al. (2024) described that HF cows function better in moderate agroecological zones of subtropical countries. Similarly, Rehman et al. (2025) concluded that the reproductive performance of local Achai can be improved through a very systematic and scientific approach to crossbreeding and improved management practices.

Milk is a white liquid that is generated by all adult female animals' mammary glands after giving birth and contains milk proteins, fat, lactose, and different vitamins and minerals. Milk is a vital component of our daily diet, essential for human growth, sustenance, and health (Irshad et al*.,* 2011). The broad composition of cow's milk is 87.7% water, 4.9% lactose, 3.4% fat, 3.3% protein, and 0.7% minerals referred to as ash (Sutton et al., 1989). The mammary glands physiologically produce milk 15 days before and 5 days after giving birth (Sutton et al., 1989). The production of high-quality animal protein for human consumption through the provision of milk and meat is the most significant function of livestock. Saleem et al. (2025) investigated the interaction of breed and seasonality on milk quality parameters in different dairy cow breeds and stated that indigenous Pakistani cattle, particularly Sahiwal are superior in terms of protein, minerals, fat, SNF, lactose, and total solids as compared to imported breeds. Limited comparative data exist on long-term performance and milk composition of HF, AF, and Jersey cattle under subtropical Pakistani conditions. Therefore, given the importance of performance traits in cattle, the present study was designed to evaluate milk and milk composition traits across different breeds and to examine factors affecting production traits in different breeds in the Khyber Pakhtunkhwa province of Pakistan.

MATERIALS AND METHODS

Ethical approval of the study

This study protocol was approved by the ethical committee of the University of Agriculture Peshawar (No. 7518/LM, B & G/UOA, dated: 29/09/2022)

Study area and selection of animals

The study was conducted at the Livestock Research and Breeding Farm, the University of Agriculture, Peshawar. Different Breeds of Animals, such as Holstein Friesian (HF), Australian Friesian (AF), and Jersey, were selected for the current experiment. Data from 2010 to 2020 were utilized in the current study. Animals were managed under identical feeding and housing conditions. Production traits were extracted from the records maintained at Livestock Research and Breeding Farm, The University of Agriculture Peshawar.

Productive parameters

Productive parameters like daily milk yield (DMY), peak milk yield (PMY), standard milk yield (SMY, 305 days), lactation yield (LY), and lactation length (LL) were recorded.

Laboratory analysis

Milk samples were collected and analyzed using an automatic milk analyzer at the Dairy Technology Center (DTC) at the University of Agriculture Peshawar, to determine milk composition.

Statistical analysis

The arranged data was subjected to the statistical package SAS V9.2. A general linear model was used for the analysis of variance, and group means were compared using the Duncan multiple-range test. The following GLM model was used for analysis.

$$Yijkl = \mu + SRi + BDj + PRk + \varepsilon ijkl \text{ ---------- (1)}$$

Where; Y_{ijkl} = effect of all response variables; μ = is the population constant; SR_i = is the i^{th} effect of Sire, i = (1, 2, 3...,14); BD_j = is the j^{th} effect of Breed, j = (1,2, and 3); PR_k = is the k^{th} effect of Parity, k = (1,2…5); and ε_{ijklm} = is the random residual error.

RESULTS

Comparison of productive traits of the breed

The results of the comparison of productive traits across breeds are shown in Table 1. The significantly highest DMY

was observed in Holstein Friesian (HF) (11.82 L) and Australian Friesian (AF) (11.62) breeds, compared to the Jersey breed (8.71 L). Similarly, the significantly highest PMY was found in HF and AF breeds (18.86 L, 18.63 L) than in the Jersey breeds (13.81). The SMY and LL were found to be non-significant across breeds.

Comparison of productive traits with parity

The results of the comparison of productive traits about parity are shown in Table 2. The highest significant DMY, PMY, and LY were recorded in the fifth parity at 13.37, 21.40, and 4079.1 L, respectively. SMY and LL were non-significant across parities; however, in the fourth parity, the highest SMY value was 3074.9 L, and LL was 334.2 days.

Table 1. Comparison of various productive traits with breed

Breed	Productive traits (Liters)				
	DMY	PMY	SMY	LY	LL (Days)
HF	11.82[a]	18.86[a]	2900.2	3593[a]	301.6
AF	11.62[a]	18.63[a]	2701.2	3536[a]	290.0
Jersey	8.71[b]	13.81[b]	2593.3	2648[b]	305.1
SEM	1.40	2.25	565.2	384.8	47.73
P-value	0.001	0.001	0.30	0.001	0.83

The mean values in the same column that don't have the same superscript (a, b) differ significantly (p<0.05).
Holstein Friesian (HF), Australian Friesian (AF), Daily milk yield (DMY), Peak milk yield (PMY), Standard 305 milk yield (SMY), Lactation yield (LY), Lactation length (LL).

Table 2. Comparison of various productive traits with parity.

Parity	Productive traits (Liters)				
	DMY	PMY	SMY	LY	LL (Days)
1st	10.28[c]	16.45[c]	2642.1	3136.2[c]	265.0
2nd	10.36[c]	16.39[c]	2617.9	3147.7[c]	290.4
3rd	11.54[b]	18.63[b]	2857.1	3509.8[b]	307.5
4th	12.45[ab]	19.71[b]	3074.9	3762.4[b]	334.2
5th	13.37[a]	21.40[a]	3029.3	4079.1[a]	301.5
SEM	1.60	2.30	435.1	213.2	30.40
P value	0.001	0.002	0.810	0.001	0.64

The mean values in the same column that don't have the same superscript (a, b, c) differ significantly (p<0.05).
Daily milk yield (DMY), Peak milk yield (PMY), Standard 305 milk yield (SMY), Lactation yield (LY), Lactation length (LL).

Milk composition of different breeds

The results for milk composition across different breeds are presented in Table 3. Findings show significantly higher fat in the milk of the Jersey breed as compared to HF and AF breeds. Protein and Solid Non-Fat (SNF) components were significantly higher in the HF breed than in the AF and Jersey breeds. Lactose, pH, and total solids (TS) components of the milk of different breeds of cattle were non-significant.

Table 3. Milk composition of different breeds of cattle

Breed	Milk composition					
	Fats	Protein	Lactose	SNF	pH	TS
HF	4.27[c]	4.11[a]	4.78	8.53[a]	6.80	13.87
AF	4.85[b]	3.64[b]	4.81	8.46[ab]	6.83	14.0
Jersey	5.08[a]	3.79 [ab]	4.78	8.42[b]	6.86	14.00
SEM	0.07	0.10	0.04	0.02	0.07	0.12
P-value	0.0001	0.03	0.69	0.04	0.57	0.44

The mean values in the same column that don't have the same superscript (a, b, c) differ significantly (p<0.05).
Holstein Friesian (HF), Australian Friesian (AF), Solid Non Fat (SNF), Total solid (TD).

Pearson's correlation between selected parameters of different breeds of cattle

Tables 4 and 5 show the results of Pearson's correlation between selected parameters of different breeds of cattle. The Pearson correlation of DMY (0.98) was positive and significant (P<0.05) with PMY and LY. Correlation of PMY with SMY, LY, and LL was found highly positive 0.98) and significant (P<0.05), while the correlation of SMY was

found positive 0.22 and 0.11 with LY and LL, respectively. Correlation of LY was positive (0.58) and highly significant (P<0.001) with LL, and the correlation of LL was positive with DMY (0.12), PMY (0.12), SMY (0.11), and LY (0.58), respectively. Correlations of Fats with Lactose (0.16), TS (0.57), and pH (0.51) were positive; however, correlations with protein (-0.62) and SNF (-0.72) were negative and non-significant (P>0.05). Protein correlation with SNF was positive (0.73); however, the correlation of protein with other milk components was non-significant (P>0.05). Lactose correlation with SNF (0.40), TS (0.75), and pH (0.53) was found highly positive and significant (P<0.05). The Pearson correlation between SNF and pH (0.05) and TS (0.02) was positive and highly significant (P<0.05). TS correlated negatively and nonsignificantly with protein (P>0.05); however, it correlated positively with other milk components. A highly positive correlation (r=0.70) between pH and TS was significant (P<0.05).

Table 4. Pearson's correlation between selected parameters of different breeds of cattle

	Parameters				
	DMY	PMY	SMY	LY	LL (Days)
DMY	1.0000	0.9851	0.9979	0.23884	0.1230
P-value	0.00	0.0001	0.0001	0.1184	0.4261
PMY	----	1.0000	0.9869	0.2088	0.1210
P-value	----	0.00	0.0001	0.1738	0.4337
SMY	----	----	1.0000	0.2211	0.1135
P-value	----	----	0.00	0.1491	0.4628
LY	----	----	----	1.0000	0.5807
P-value	----	----	----	0.00	0.0001
LL (Days)	----	----	----	----	1.0000
P-value	----	----	----	----	0.00

Daily milk yield (DMY), Peak milk yield (PMY), Standard 305 milk yield (SMY), Lactation yield (LY), Lactation length (LL).

Table 5. Pearson's correlation of milk composition of different breeds of cattle

	Milk composition					
	Fat	Protein	Lactose	SNF	PH	TS
Fat	1.0000	-0.6285	0.16252	-0.7239	0.5144	0.5739
P-value	0.00	0.0698	0.6761	0.6761	0.1565	0.1061
Protein	----	1.0000	0.0183	0.7365	-0.1217	-0.1647
P-value	----	0.00	0.9626	0.0236	0.7550	0.6719
Lactose	----	----	1.0000	0.4050	0.5368	0.7568
P-value	----	----	0.00	0.2795	0.1362	0.0182
SNF	----	----	----	1.0000	0.0555	0.0236
P-value	----	----	----	0.00	0.8871	0.9518
PH	----	----	----	----	1.0000	0.7052
P-value	----	----	----	----	0.00	0.0338
TS	----	----	----	----	----	1.0000
P-value	----	----	----	----	----	0.00

Solid Non Fat (SNF), Total solid (TS).

DISCUSSION

This study evaluated milk composition traits and factors affecting production traits across different cattle breeds in the Khyber Pakhtunkhwa province of Pakistan. The results showed higher daily milk yield (DMY) for the HF breed compared to the Australian Friesian (AF) and Jersey breeds. Similar results were reported by Carvajal-Hernández et al. (2002), who reported 12.29 ± 0.28 L DMY in HF. The results also agree with Tadesse and Dessie (2003), who reported a value of 9.43 ± 0.39 L DMY. Walsh et al. (2008) also described a highly significant (*P*<0.05) effect of breed concerning all milk yield variables. Similarly, Vance et al. (2013) documented higher significance (*P*<0001) DMY in HF as compared to crossbred. The highest PMY was observed in the HF breed, followed by the Jersey breed, which is consistent with the results of Rao et al. (2000), who reported PMY of 7.0 to 12.7 L. Bondan et al. (2018) reported that parity and lactation stage were positively associated with milk yield. Similarly, Rehman et al.

(2024) reported that HF cows perform better in the moderate agroecological zones of subtropical countries.

The standard milk yield (SMY) and lactation length (LL) were found to be non-significant among the different breeds, and similar results were reported by Sattar et al. (2005), who recorded 499 productive data points for Holstein Friesian and found an average standard 305 milk yield of 2772.76 ± 65.0 L. The results of the current study are also in agreement with Carvajal-Hernández et al. (2002), who observed that the overall mean of SMY (305) was 2918 ± 67.6 L and 2635 ± 51.9 L, respectively. A similar result was reported by Carvajal-Hernández et al. (2002), who reported 3475.5 ± 78.8 L LY across different breeds of cattle. Osman and Kassim (1983) reported that the LY of the HF breed in Pakistan was 3139.49 ± 56 L. Sandana and Basu (1981) and Cheema (1985) reported that the SMY of HF ranged from 3911 to 5259 L. Similar results were reported by Irshad et al. (2011) and Sattar et al. (2005), who reported LLs of 299.6 ± 13.64 to 356.93 ± 12.50 days and 291.86 ± 6.55 days, respectively. The results of the current study also agree with those of Usman et al. (2012), who reported 185-514 days, with an average of 366.5 ± 76.71 days. Perez and Ronda (1983) note the average 315 ± 17.9 days LL in India. Taj et al. (2001) observed 265 days of LL at Punjgoor, Pakistan, while Oliveria (1975) recorded 392 days of LL in HF in Brazil.

The significantly highest DMY, PMY, and LY were recorded in the fifth parity. SMY and LL were non-significant across parities; however, in the fourth parity, the highest SMY was 3074.9 L, and LL was 334.2 days. Li and Kim (2006) found SMY at 8,431, 9,774, 10,191, 10,812, and 10,611 L for the 1st, 2nd, 3rd, 4th, and 5th parities, respectively, and reported that SMY increases with advanced parity ($P<0.01$). Khattab et al. (2005) investigated 2095 records of HF across different parities; e.g., the 3rd was 4984 ± 58 L, followed by the 4th at 4868 ± 59 L, and the 5th at 4389 ± 85 L. Rehman et al. (2008) found a correlation of first calving with a 305-day milk yield of 0.72. Sandhu et al. (2011) observed SMY in first parity at 3848.0 ± 15.77 L, followed by 2nd at 4303.7 ± 32.79 L, 3rd at 4431.4 ± 41.65 L, 4th at 4186.3 ± 49.59 L, and 5th at 3767.61 ± 35.38 L, with an overall mean of 3977.75 ± 37.20 L.

Significantly higher fat in the milk of Jersey breeds as compared to HF and AF breeds, while the protein and Solid Non-Fat (SNF) components were significantly higher in the HF breed than in the AF and Jersey breeds. Similar results were reported by Sudhakar et al. (2013), who studied the milk composition of Jersey crossbred and reported fat 4.50±0.35 %, SNF 8.92 %, protein 3.25±0.06 % and lactose 4.88±0.089 %. Bondan et al. (2018) found in HF crossbred fats 3.81 ± 0.34 %, SNF 9.13 ± 0.16 %, protein 3.25 ± 0.06 %, and lactose 5.06 ± 0.09 % respectively. The results of the current study are consistent with those of Ribeiro et al. (2012), who reported mean values of 3.66% for fat, 3.16% for protein, 4.41% for lactose, and 12.10% for total solids.

CONCLUSION

The highest production performance was observed in the HF breed at fifth parity, indicating greater environmental adaptability and suitability for farming in Pakistan's local conditions. Daily milk yield was highly correlated with peak milk yield and standard 305-day milk yield. Lactation length was found to be highly correlated with lactation yield. Negative correlations were found between fat and lactose, and between protein and total solids; however, other correlations among milk components were positive. Traits of economic importance were found to be better in the Holstein Friesian breed of cattle, so it is recommended that this type of breed should be raised for future breeding purposes. Also, advanced parity animals, such as (fourth and fifth), should be maintained on the farm and avoid culling if not diseased. Production of the animals increased with advancing parities, which can be helpful for selection indices in exotic breeds. Daily milk yield should be given higher priority and better managed to improve an animal's performance record.

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AUTHOR CONTRIBUTIONS

Wajid Ullah: Conceptualization, methodology, formal analysis, writing-review & editing. Syed Muhammad Suhail: Supervision, conceptualization, methodology, interpreted the study findings, writing-review & editing. Muhammad Shuaib: Formal analysis, software, writing-original draft preparation, visualization. Sohaib Ul Hassan, Abubakar Sufyan, Obaid Ullah, Danyal Khan, Muhammad Shahkar Uzair, Maryam Iqbal: Validation, data curation, writing-review & editing. All authors read and approved the final manuscript.

COMPETING OF INTEREST

The authors declare no competing interests.

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