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Effect of Environmental Factors on Milk Production Traits and Energy-Corrected Milk Yield in Karan Fries Cattle

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ABSTRACT

The present study was conducted to analyze milk production traits and energy-corrected milk yield using 11569 first lactation milk production records of 1393 Karan Fries cows, calved between 1989 and 2014. The overall least-squares means of first lactation milk production traits viz. fat %, solids-not-fat (SNF)%, total solids (TS) %, 305 days milk yield (305dMY), fat yield (FY), SNF yield (SNFY), TS yield (TSY), the energy value of milk (E) and energy corrected milk yield (ECMY) were 4.20±0.01, 8.77±0.01, 12.97±0.01, 3142.58±24.45 kg, 132.37±1.03 kg, 275.41±2.14 kg, 407.78±3.16 kg, 750.57±0.60 Kcal kg^{-1} and 3229.88±24.37 kg, respectively. All the yield traits including ECMY were found higher in the autumn season and lower in the summer season. The ECMY was highest for the cows calved after 37 months of age and lowest for the cows calved at an early age. The milk fat % had a very high and positive correlation with TS %, indicating that cows with higher fat content tend to have higher TS content in milk, whereas, SNF % had a very low and negative correlation with all the milk production traits except TS % and energy value of milk. The correlation between 305dMY and ECMY was also found to be very high and positive, indicating that the current breeding policy based on milk yield of cows for genetic improvement of dairy breeds is in the right direction as it tends to increase milk yield along with energy-corrected milk yield of animals.

KEYWORDS: Environmental factors, milk constituents, energy, yield, Karan Fries

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1. INTRODUCTION

Nutritional status of any region is assessed by dietary energy intake of its population. In India, particularly in rural areas, dietary energy intake is lower than the recommended levels (Hemalatha et al., 2023). However, milk is being consumed as one of the major non-cereal dietary energy sources throughout the world (Maletta, 2014). The rapid population growth is the main driver of increased demand for milk and dairy products in the country. In India, milk production has been increased significantly during the past few decades, registering the growth rate of 3.83% over the previous year (2021–22) and making it the world's largest producer of milk (Anonymous, 2023). Total milk production in the country is 230.58 mt and the only 51.36 million population of exotic and crossbred cattle produces 31.67% of the total milk in the country (Anonymous, 2023). The shares of exotic and crossbred cattle are higher because of their higher milk-yielding capacity in comparison to other milk-producing breeds in India (Singh, 2016; Al Kalaldeh et al., 2021). Among the various crossbred cattle developed in the country, Karan Fries (KF) has evolved as an important milch breed. In 1980's, the KF cattle have been developed at the National Dairy Research Institute (NDRI) Farm, Karnal as a result of the crossbreeding of Tharparkar as Zebu cattle with Holstein Friesian bull with 50–75% exotic level of inheritance, followed by selection among inter-se mated population (Kour et al., 2018; Gonge et al., 2024)

Among production traits, the milk yield of dairy animals has received major emphasis in the world till now, whereas, the milk constituents' and milk energy value received very little attention in breed improvement programs (Dillon et al., 2006; Miglior et al., 2017). Increase in milk production with less attention to these constituents or energy traits, has not only affected the marketing of milk products, but also the nutritional quality of the nature's most nearly perfect food. In view of the nutritional security of the country, milk constituents must be given proper weightage along with milk yield in the breed improvement programs (Clay et al., 2020; Brito et al., 2021).

The components of milk change during the course of lactation and are determined by an animal's genetic make-up as well as non-genetic/environmental factors including the year, season, lactation stage, animal age, parity, etc (Pandiyan et al., 2022; Chandrakar et al., 2017; Sahin et al., 2012). To minimize the impact of non-genetic factors, it is essential to quantify the effect of each non-genetic factor and to adjust its effect for formulating management and breeding strategies to improve the quality as well as quantity of milk of dairy animals. Moreover, the knowledge of the correlation among different milk production and energy traits might be useful in determining the method of selection to predict direct and correlated response to selection, choosing a breeding system to be adopted for future improvement as well as in the estimation of genetic response (Verma et al., 2017). Till date, several studies have been reported on incorporating milk yield in selection criteria in HF crossbred cattle (Kokate et al., 2014; Divya et al., 2014; Dash et al., 2018), however, studies on milk constituent and energy traits are limited. The present study was thus undertaken to quantify variation in first lactation milk production traits and energy-corrected milk yield over the year, season, age of cows, and days in milk; and to assess the relationship among milk production and milk energy traits in KF crossbred cattle.

2. MATERIALS AND METHODS

2.1. Data source

A total of 11569 first lactation test day records of 1393 Karan Fries cows, calved between 1989 and 2014 at ICAR-National Dairy Research Institute, Karnal, were analyzed. Adult cows are maintained under a loose housing system on the farm. Cows were provided with *ad libitum* green fodder and roughages. A concentrate ration was provided according to milk yield to meet the production requirement of cows. Monthly test day (date of milk testing) records of milk fat, solids-not-fat (SNF) contents, and milk yield were collected. Total solids (TS) content was derived by taking the summation of fat and SNF content. A total of 10 monthly test days with intervals of 28-35 days were considered. The milk production traits analyzed in the study were first lactation fat %, SNF%, TS %, 305 days milk yield (305dMY), fat yield (FY), SNF yield (SNFY) and total solids yield (TSY). The milk production yield traits viz. FY, SNFY and TSY were estimated using the formula: Y = MC× 10; where Y is the milk production yield trait in grams and MC is the respective milk constituent trait in percentage.

2.2. Statistical analysis of data

Cow milk containing a minimum of 4 % fat was considered as standard criteria in India according to The Prevention of Food Adulteration Act and Rules (Anonymous, 2004). Therefore, the prediction models for the first lactation energy corrected milk yield (305dECMY) were developed for 4% corrected fat for KF cattle, by using the following formulas:

305dECMY (4%)=(305dMY×E)÷730.28

where,

305dECMY=First lactation 305 days energy corrected milk yield

305dMY=First lactation 305 days milk yield

E=First lactation energy value kg^{-1} of milk

First lactation energy value per kg of milk (E) was calculated using energy values of fat and SNF as 9.3 Mcal kg^{-1} and 4.1

Mcal kg^{-1} (Karlson, 1965). The figures viz. 730.28 is the energy equivalent for one kg of milk of KF cattle with 4% fat (Upadhyay, 2016).

The effect of environmental factors such as the year of calving, the season of calving, days in milk (covariate), and age at first calving (AFC) was assessed on milk production and energy traits using the GLM procedure (PROC GLM) of SAS 9.3 software (Anonymous, 2012). The relationships among all the milk production and energy traits were assessed by estimating Pearson's correlation coefficient between the phenotypic values using the CORR Procedure (PROC CORR) of SAS 9.3 software (Anonymous, 2012). The years of calving from 1989 to 2014 were taken in the analysis. Each year was sub-classified into four seasons winter (December to March), summer (April to June), rainy (July to September), and autumn (October to November. Cows were classified into three age groups such as ≤30 months, 31–36 months, and ≥37 months based on age at first calving. Days in the milk of cows were taken as a covariate function in the model. The fixed model used to assess the influence of non-genetic factors on milk production traits and ECMY was:

$$Y_{ijklm}=\mu +Yr_i+S_j+A_k+ b(DIM_i-\overline{DIM})_l+e_{ijklm}$$

where Y_{ijklm} was one of the milk production traits or ECMY. The fixed effects were the ith year (Yr_i), jth season of calving (S_j), kth age group (A_k), b $(DIMi-\overline{DIM})_l$ was the fixed effect of lth days in milk (covariate), where b is the regression coefficient of the observation (Y) on days in milk (DIM) and e_{ijklm} was random error {~NID (0, σ_e^2)} was assumed to be normally and independently distributed with a mean of '0' and an unknown variance of σ_e^2.

3. RESULTS AND DISCUSSION

3.1. *Milk production traits*

The overall least-squares means for first lactation milk fat %, SNF % and TS % were 4.20±0.01, 8.77±0.01 and 12.97±0.01%, respectively (Table 1). A nearly similar estimate of milk fat % was reported by Tripathy (2015) and slightly lower estimates than the present study were reported by Misra (2001) and Sarkar et al. (2006) in KF cattle. Nearly similar estimates of SNF % and TS % were reported by Misra (2001) and higher estimates in comparison to the present study were reported by Sarkar et al. (2006). The analysis of variance revealed that the year of calving had a highly significant (p<0.01) influence on milk fat, SNF, and TS percent. Age at first calving had a highly significant (p<0.01) influence on SNF %. The effect of season of calving and days in milk (as a covariate) on milk fat, SNF and TS percent was found non-significant. Age at first calving also had a non-significant effect on milk fat and TS percent. Similar to the findings of the present study, Verma et al., 2016 also reported statistically significant effect of period of calving on milk yield in 305 days or less, lactational average fat % and lactational average solid not fat % and non-significant effect of season of calving on all the abovementioned traits in Sahiwal cows. However, Koc, 2011 reported significant effect of season and stage of lactation on milk fat, SNF and TS content in HF and Montbeliarde cows.

In the present study, milk fat % was found highest (4.45±0.02%) for the KF cows calved during 2007 and the lowest (3.94 ± 0.02 %) for the cows calved during 1997. The SNF % was found highest (8.92±0.01%) for the cows calved during 1989 and lowest (8.65±0.01%) for the cows calved during 1995. The differences in milk constituent traits over the years may be attributed to differences in feeding and management practices besides the variability of herd size over the years. Regarding the effect of AFC, cows with AFC of less than 30 mo. had slightly higher (8.77±0.01) SNF % in comparison to other groups. This indicated the KF cows that calved at an early age had comparatively higher SNF % than the KF cows that calved at later ages. Similar to the findings of the present study, Tripathy (2015) reported a significant effect of the period of calving and a non-significant effect of the season of calving on fat % in KF cattle. Similarly, Misra (2001) reported a significant influence of the period of calving on SNF and TS percent. However, contrary to the findings of the present study, Tripathy (2015) reported a significant effect of AFC on fat % in KF cattle.

The overall least-squares mean of first lactation 305dMY, FY, SNFY and TSY were 3142.58±24.45 kg, 132.37±1.03 kg, 275.41±2.14 kg and 407.78±3.16 kg, respectively (Table 1). Nearly similar estimates of first lactation 305dMY were also reported by Tripathy (2015). However, lower estimates of 305dMY in KF cows than the present study were reported by Misra (2001) and Kokate (2009) and higher estimates than the present study were reported by Nehara (2011) and Yadav et al., 2017 at NDRI farm. Moreover, Yadav et al., 2017 reported higher FY and lower SNFY in comparison to present study in KF cattle. Differences in estimates of 305dMY in KF reported by various workers may be attributed to differences in culling policies for milk production, management and climatic factors over the periods. The ANOVA revealed that year of calving, season of calving and days in milk had a highly significant (p<0.001) influence on all the yield traits, whereas, age at first calving had a non-significant influence on all the yield traits. The first lactation FY was found highest (161.38±3.89 kg) for the cows calved during 2009 and lowest (97.33±4.56 kg) for the cows calved during 1998. Regarding the effect of season of calving, autumn season calvers had the highest (139.72±2.43 kg) FY and summer season calvers had the

Table 1: Least-squares means for first lactation milk constituent traits in Karan Fries cattle

Effect	N	Fat %	SNF %	TS %	305dMY (kg)	FY (kg)	SNFY (kg)	TSY (kg)	E (K cal kg^{-1})	ECMY (kg)
Overall (μ)	1393	4.20± 0.01	8.77± 0.01	12.97± 0.01	3142.58± 24.45	132.37± 1.03	275.41± 2.14	407.78± 3.16	750.57± .60	3229.88± 24.37
Year of calving		***	***	***	***	***	***	***	***	***
1989	57	4.21^{defg} ±0.03	8.92^{i}± 0.01	13.13^{jk}± 0.03	3138.01^{bcdefg} ± 98.02	132.20^{bcdefg} ± 4.14	279.85^{bcdef} ± 8.58	412.05^{bcdefg} ± 12.67	757.57$^{ef gh}$± 2.46	3262.20^{bcdefg} ± 100.24
1990	44	4.15^{cd} ±0.03	8.89^{i}± 0.01	13.04^{hijk} ±0.03	2933.32^{abcd} ± 110.86	121.84^{abcd} ± 4.68	260.57^{abc} ± 9.70	382.41^{abcd} ± 14.34	750.89^{defg} ± 2.78	3023.06^{abcd} ± 113.37
1991	54	4.10^{bcd} ±0.03	8.91^{i}± 0.01	13.01^{efghij} ±0.03	3255.65^{bcdefg} ± 100.47	133.27^{bcdefg} ± 4.25	289.88^{bcdef} ± 8.79	423.16^{bcdefg} ± 12.99	746.71^{cde} ± 2.52	3324.92^{bcdefg} ± 102.55
1992	74	3.99^{ab} ±0.02	8.80^{h}± 0.01	12.79^{b}± 0.03	3396.64^{cdefgh} ± 84.67	135.58^{cdefgh} ± 3.58	298.76^{cdef} ± 7.41	434.34^{cdefgh} ± 10.95	731.98^{ab} ± 2.12	3401.14^{cdefgh} ± 86.50
1993	56	4.11^{bcd} ±0.03	8.77^{fgh} ±0.01	12.88^{bcdefg} ±0.03	3028.45^{abc} ± 97.39	124.80^{abc} ± 4.12	265.68^{abc} ± 8.52	390.48^{abc} ± 12.59	742.05^{bcd} ± 2.45	3081.22^{abc} ± 99.58
1994	18	4.08^{bcd} ±0.04	8.77^{gh} ±0.02	12.86^{bcde} ±0.05	2953.40^{abcd} ± 171.64	120.02^{abcd} ± 7.25	258.99^{abc} ± 15.02	379.01^{abcd} ± 22.19	739.67^{bcd} ± 4.31	2993.42^{abcd} ± 175.69
1995	66	3.95^{a} ±0.02	8.65^{a} ±0.01	12.60^{a}± 0.03	2979.38^{abcdef} ± 89.84	117.80^{abcdef} ± 3.80	257.96^{abcd} ± 7.86	375.76^{abcdef} ± 11.62	721.91^{a} ± 2.26	2949.24^{abcdef} ± 91.96
1996	57	4.02^{abc} ±0.02	8.77^{fgh} ±0.01	12.79^{bc}± 0.03	3018.89^{abcde} ± 96.59	121.32^{abcde} ± 4.08	264.34^{abcd} ± 8.45	385.66^{abcde} ± 12.49	733.71^{abc} ± 2.42	3031.80^{abcde} ± 98.67
1997	79	3.94^{a} ±0.02	8.68^{ab} ±0.01	12.62^{a}± 0.03	2837.96^{ab} ± 82.67	112.00^{ab} ± 3.49	246.32^{ab} ± 7.24	358.33^{ab} ± 10.69	722.54^{a} ± 2.07	2810.25^{ab} ± 84.46
1998	46	4.13^{cd} ±0.03	8.71^{bcde} ±0.01	12.84^{bcd}± 0.03	2358.66^{a} ± 108.02	97.33^{a}± 4.56	205.52^{a} ± 9.45	302.86^{a} ± 13.97	741.08^{bcd} ± 2.70	2391.83^{a} ± 110.13
1999	34	4.16^{cde} ±0.03	8.80^{h}± 0.01	12.96^{defghi} ±0.04	2706.21^{abcd} ± 124.48	112.22^{abcd} ± 5.26	238.22^{abc} ± 10.89	350.44^{abc} ± 16.10	747.72^{de} ± 3.13	2775.36abc ± 127.45
2000	52	4.14^{cd} ±0.03	8.78^{fgh} ±0.01	12.91^{bcdefgh} ±0.03	2683.44^{abcd} ± 101.29	111.10^{abcd} ± 4.28	235.48^{abc} ± 8.86	346.58^{abc} ± 13.10	744.56^{bcd} ± 2.55	2726.63^{abc} ± 103.70
2001	45	4.18^{def} ±0.03	8.78^{gh} ±0.01	12.96^{defghi} ±0.03	2817.79^{abcde} ± 108.91	117.46^{abcde} ± 4.60	247.36^{abcd} ± 9.53	364.82^{abcdef} ± 14.08	749.25^{def} ± 2.74	2879.51^{abcdef} ± 111.44
2002	57	4.11^{bcd} ±0.02	8.78^{gh} ±0.01	12.88^{bcdef} ±0.03	3130.35^{bcdefg} ± 96.68	128.25^{bcdefg} ± 4.09	274.73^{bcde} ± 8.46	402.98^{bcdefg} ± 12.50	741.95^{bcd} ± 2.43	3168.03^{bcdefg} ± 98.90
2003	56	4.20^{defg} ±0.02	8.76^{defgh} ±0.01	12.96^{cdefghi} ±0.03	2815.85^{abcd} ± 97.33	118.54^{abcd} ± 4.11	246.58^{abc} ± 8.52	365.13^{abcd} ± 12.59	749.94^{def} ± 2.44	2890.68^{abcd} ± 99.47
2004	59	4.36^{hi} ±0.02	8.76^{efgh} ±0.01	13.12^{ijk}± 0.03	3187.55^{bcdefgh} ± 94.97	38.94^{bcdefgh} ± 4.01	279.36^{bcdef} ± 8.31	418.30^{cdefgh} ± 12.28	764.66^{ghi} ± 2.38	3339.16^{cdefgh} ± 96.95
2005	56	4.30^{fgh} ±0.03	8.76^{efgh} ±0.01	13.06^{hijk} ±0.03	3602.91$^{ef gh}$ ± 97.71	154.95^{efgh} ± 4.13	315.61^{def} ± 8.55	470.55^{gh} ± 12.63	759.20$^{ef ghi}$± 2.45	3747.44^{gh} ± 99.82
2006	89	4.30^{efgh} ±0.02	8.77^{fgh} ±0.01	13.06^{hijk} ±0.02	3232.48^{bcdefgh} ± 77.25	138.28^{bcdefgh} ± 3.26	283.51^{bcdef} ± 6.76	421.79^{bcdefg} ± 9.99	759.10$^{ef ghi}$± 1.93	3347.19^{cdefg} ± 78.64
2007	66	4.45^{i} ±0.02	8.75^{defg} ±0.01	13.20^{k}± 0.03	3449.24$^{def gh}$ ± 89.63	153.48^{defgh} ± 3.79	301.55^{cdef} ± 7.84	455.03^{efgh} ± 11.59	772.68^{i} ± 2.25	3645.81^{fgh} ± 91.50
2008	65	4.41^{hi} ±0.02	8.71^{bcd} ±0.01	13.12^{ijk}± 0.03	3508.06^{fgh} ± 90.05	154.89^{fgh} ± 3.81	305.53^{def} ± 7.88	460.42^{gh} ± 11.64	766.92^{hi} ± 2.26	3687.14^{gh} ± 92.06

Table 1: Continue...

Effect	N	Fat %	SNF %	TS %	305dMY (kg)	FY (kg)	SNFY (kg)	TSY (kg)	E (K cal kg^{-1})	ECMY (kg)
2009	63	4.37^{hi} ±0.02	8.70^{abc} ±0.01	13.07^{hijk} ±0.03	3691.86^{h} ± 92.04	161.38^{h} ± 3.89	320.82^{f} ± 8.06	482.20^{h} ± 11.90	762.89^{fghi} ± 2.32	3851.12^{h} ± 94.30
2010	66	4.33^{ghi} ±0.02	8.70^{abc} ±0.01	13.03^{efghij} ±0.03	$3509.34^{ef gh}$ ± 90.55	151.99^{efgh} ± 3.83	305.17^{def} ± 7.93	457.15^{fgh} ± 11.71	759.32^{efgh} ± 2.28	3640.02^{gh} ± 92.82
2011	38	4.32^{fgh} ±0.03	8.77^{efgh} ±0.01	13.08^{ijk} ± 0.04	3334.26^{cdefgh} ± 118.54	144.16^{cdefgh} ± 5.01	292.59^{cdef} ± 10.37	436.75^{defgh} ± 15.33	760.74^{efghi} ± 2.99	3465.79^{efgh} ± 121.60
2012	46	4.32^{fghi} ±0.03	8.74^{cdefg} ±0.01	13.06^{ghijk} ±0.03	3641.25^{gh} ± 107.66	157.26^{gh} ± 4.55	318.19^{ef} ± 9.42	475.45^{gh} ± 13.92	760.34^{efghi} ± 2.71	3778.61^{gh} ± 110.40
2013	33	4.31^{fgh} ± 0.03	8.73^{bcdef} ± 0.01	13.04^{fghij} ± 0.04	3319.07^{cdefgh} ± 126.75	142.72^{cdefgh} ± 5.36	289.50^{cdef} ± 11.09	432.21^{defgh} ± 16.39	758.78^{efgh} ± 3.19	3438.22^{defgh} ± 129.82
2014	17	4.39^{hi} ± 0.04	8.77^{fgh} ± 0.01	13.17^{jk} ± 0.05	$3177.11^{bcdefgh}$ ± 175.65	$139.74^{bcdefgh}$ ± 7.42	278.57^{bcdef} ± 15.37	418.30^{cdefgh} ± 22.71	768.60^{hi} ± 4.42	3327.0^{cdefgh} ± 179.86
Season of calving		NS	NS	NS	**	**	**	**	NS	***
Summer	368	4.20± 0.01	8.77± 0.01	12.97± 0.01	3046.14^{a} ± 38.78	128.49^{a} ± 1.64	266.10^{a}± 3.39	395.49^{a}± 5.02	750.50 ± 0.97	3132.66^{a} ± 39.49
Rainy	240	4.20± 0.01	8.76± 0.01	12.96± 0.02	3092.06^{a} ± 48.73	129.85^{a} ± 2.06	270.87^{a}± 4.26	400.72^{a}± 6.30	749.75 ± 1.21	3171.88^{a} ± 49.36
Autumn	170	4.22± 0.01	8.77± 0.01	12.99± 0.02	3305.20^{b} ± 57.62	139.72^{b} ± 2.43	289.79^{b}± 5.04	429.51^{b}± 7.45	752.18 ± 1.44	3406.73^{b} ± 58.80
Winter	615	4.20± 0.01	8.76± 0.01	12.96± 0.01	3126.92^{a} ± 31.31	131.40^{a} ± 1.32	273.98^{a}± 2.74	405.38^{a}± 4.05	749.84 ± 0.77	3208.23^{a} ± 31.44
Age at first calving (mo.)		NS	*	NS	NS	NS	NS	NS	NS	*
≤30	393	4.22± 0.01	8.77^{c}± 0.01	12.99± 0.01	3083.97 ± 40.97	130.42 ± 1.73	270.49± 3.59	400.91± 5.30	751.73 ± 1.03	3178.16^{a} ± 41.95
31-36	702	4.21± 0.01	8.77^{b}± 0.01	12.98± 0.01	3121.08 ± 29.84	131.56 ± 1.26	273.61± 2.61	405.17± 3.86	750.69 ± 0 .79	3193.00^{a} ± 32.12
≥37	298	4.19± 0.01	8.76^{a}± 0.01	12.95± 0.01	3222.69 ± 45.61	135.11 ± 1.93	282.13± 3.99	417.24± 5.90	749.28 ± 1.03	3318.47^{b} ± 42.01

* Significant (p<0.05); ** Significant (p<0.01); *** Significant (p<0.001); NS (p>0.05); a,b,c,d,e: Means within each column not bearing a common superscript differ significantly at p<0.05

lowest (128.49±1.64 kg) FY. The first lactation SNFY was found highest (320.82±8.06%) for the cows calved during 2009 and lowest (205.52±9.45%) for the cows calved during 1998. Regarding the effect of season, autumn season calvers had the highest (289.79±5.04 kg) SNFY and summer season calvers had the lowest (266.10±3.39 kg) SNFY. The TSY was also found highest (482.20±11.90 kg) for the cows calved during 2009 and lowest (302.86±13.97 kg) for the cows calved during 1998. Regarding the effect of the season of calving autumn season calvers had the highest TSY (429.51±7.45) and summer season calvers had the lowest TSY (395.49±5.02 kg). Similarly, a maximum of 305dMY (3691.86±92.04 kg) was observed for the cows calved during 2009 and a minimum (2358.66±108.02 kg) for the cows calved during 1998. Regarding the effect of season, a maximum (3305.20±57.62 kg) of 305dMY was observed in autumn season calvers and a minimum (3046.14±38.78 kg) of 305dMY was observed in summer season calvers. Lower 305dMY in the KF cows calved during the summer season may be attributed to the hot and humid climatic conditions encountered during the summer season which imparted heat stress to cows and reduction in milk production. KF cows calved during the autumn season received favourable climatic conditions and yielded a higher quantity of milk.

3.2. Energy value of milk and energy corrected milk yield

The overall least-squares mean of the energy value of milk in Karan Fries cows was estimated as 750.57±.60 Kcal kg^{-1}. Earlier, Tripathy (2015) reported energy based on fat, protein and lactose as 777.88±2.91 Kcal kg^{-1} in KF cows. The energy value of milk in KF cows was significantly (p<0.001) influenced by the year of calving only. Season of calving, AFC groups and DIM had non-significant effects on the energy value of milk. Maximum energy value of milk (772.68±2.25 Kcal kg^{-1}) was found in the cows calved during 2007 and minimum (721.91±2.26 Kcal kg^{-1}) was found in the cows calved during 1995. Similar to the present finding, Tripathy (2017) also reported a significant effect of the period of calving and a nonsignificant effect of the season of calving on the energy value of milk.

The overall least square mean of ECMY was 3229.88±24.37 kg. ECMY was significantly influenced by the year of calving, the season of calving, AFC and DIM. The means of ECMY was found highest in the year 2009 (3851.12±94.3 kg) and minimum in the year 1998 (2391.83±110.13 kg). Concerning season, autumn season calvers had the highest ECMY (3406.73±58.8 kg) and summer season calvers had the lowest ECMY (3132.66±39.49 kg). Concerning AFC, cows having AFC ≤30 mo had lowest the ECMY (3178.16±41.95) 186 and cows having ≥37 mo had the highest ECMY (3318.47±42.01).

3.3. Relationship among the milk production traits

The phenotypic correlations between all the milk constituents and yield traits are depicted in Table 2. It revealed that SNF % had a low but positive correlation with fat % (0.19) and energy value of milk (0.344), and moderate correlation with TS % (0.504), whereas, a very low and negative correlation with 305dMY (-0.065) and FY (-0.034) was found. The milk fat % had a very high and positive correlation with TS % (0.944) and the energy value of milk (0.987), indicating higher TS % and energy value of milk can be achieved when selecting cows for higher milk fat percent. Similar to the findings of present study Chandrakar et al., 2017 reported positive correlation of milk fat % with SNF % and TS % in crossbred cows. The correlations among milk fat % and 305dMY were low and positive (0.134). The correlation between 305dMY and ECMY was found to be very high and positive (0.995), which indicates that the current breeding policy for genetic improvement of dairy cows based on milk yield is in the right direction as cows with higher milk yield also had higher energy corrected milk yield. Similar to the findings of the present study Singh et al., 2020 also reported very high correlation between 305dMY and ECMY in KF cattle.

Table 2: Pearson correlation coefficients between first lactation milk production and milk energy traits on Karan Fries cattle

	SNF %	TS %	305dMY %	Fat yield	SNF yield	TS yield	E	ECMY
Fat %	0.190**	0.944**	0.134**	0.297**	0.140**	0.193**	0.987**	0.22**
SNF %		0.504**	-0.065*	-0.034**	-0.033^{NS}	-0.033^{NS}	0.344**	-0.036^{NS}
TS %			0.096**	0.249**	0.112**	0.158**	0.984**	0.181**
305dMY				0.984**	0.999**	0.998**	0.118**	0.995**
Fat yield					0.985**	0.993**	0.278**	0.996**
SNF yield						0.998**	0.128**	0.996**
TS yield							0.179**	0.999**
E								0.204**

* Significant (p<0.05); ** Significant (p<0.01); NS (p>0.05)

4. CONCLUSION

All the yield traits including ECMY were higher in the autumn season and lower in the summer season. ECMY was higher for the cows calved after 37 months of age in comparison to early-age calvers. The milk fat % had a very high and positive correlation with TS % and E, indicating that, cows with higher fat content might be selected for higher TS content and E. Correlation between 305dMY and ECMY was found to be very high and positive, which indicated that the current breeding policy for genetic improvement of dairy cows based on milk yield was on the right direction as cows with higher milk yield also had higher energy corrected milk yield.

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