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Studies on effect of climatic parameters on milk quality of Deoni cattle

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Abstract
The study was undertaken to evaluate the effect of climatic parameters on milk quality of Deoni cattle. The duration of research work was 52 weeks on available Deoni cows at Cattle Cross Breeding Project, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The readings of temperature and humidity in cattle shed will be recorded twice in a day by using wet and dry bulb thermometer and the data of temperature, humidity, evapotranspiration, sunshine hours, wind velocity of surrounding environment was taken from meteorological observatory at the university campus which is situated in the vicinity of this farm, to investigate the seasonal variations of milk from Deoni cows during summer, rainy and winter season. It was observed that average fat percentage (3.57 $\pm$ 0.016) and SNF percentage (8.55 $\pm$ 0.008). Climatic variables such as temperature and humidity related parameter found to have negative relationship with milk fat and SNF percentage where as sunshine hours was a positive relation. All the climatic factors considered in the study accounted for 58 per cent direct variation on fat percentage and 69 per cent direct variation on SNF percentage verified by value of coefficient of determination(R^2). As Deoni cattle are originated in this region they did not suffer much for heat stress.

Keywords: climatic parameters, milk quality and Deoni cattle

Introduction
Cattle are the foundation of Indian farming and importance as milk and draught animal has been recognized since ages together. Besides occupying a pivotal position in the diet of the people in India, milk and its various products constitute the important livestock products. It makes a sizeable contribution to the national economy. So far as the productivity is concerned, the indigenous cattle are by far below the level of economic viability. Improvements in production and performance traits of indigenous breeds become essential to make them economically viable (Wadekar *et al.*, 2012) [8].

Milk as one of the most common foods in human's life is consumed directly without any further processing, so its physical (colour and odour), chemical (fat and protein percent, freezing point, specific gravity etc.) and microbiological (microbial count and TCC) properties are of great importance (Shokoohmand *et al*., 2012) [7]. The composition of milk is of great importance for dairy industry and there is great interest in changing the composition of milk (Fox and McSweeney, 1998) [2]. Furthermore, there is no doubt that cows should live in an optimum environmental condition (animal welfare aspects) to be productive in both quantitative and qualitative aspects (Reza *et al*., 2015) [6].

Among the various factor affecting animal productivity climate is one. Climate and weather can have strong influences on farm animal production systems because they can be environmental stressors that, if they affect physiological processes, have a negative effect on animal welfare and productivity (Gomes Da Silva, 2006).

Effect of climate change on livestock production in two types i.e. direct and indirect. Direct effect includes health, production, growth and reproduction. Indirect effect includes livestock pasture, forage crop production, heat stress, biodiversity, disease and pest and immune system (Chauhan and Ghosh, 2015) [1]. The chemical composition of milk varies greatly as a consequence of numerous factors such as species, breed of animal, climate, season, lactation etc. Feeding system and seasonal variation have effect in composition of milk especially in fatty acid (Frelich *et al*., 2012) [3].

In Marathwada region, Deoni is one of the important dual-purpose cattle breed. Deoni as other indigenous cattle of India have been evolved through several generations of natural selection in the humid and subtropical climate. The importance of animals lies in their draught power capacity, heat tolerance, disease resistance, adaptability to harsh agro-climatic conditions and ability to survive and perform under scarcity of feed and fodders.

Materials and methods

Study Location

This study was conducted at Cattle Cross Breeding Project (CCBP), VNMKV, Parbhani, Maharashtra, India, which is located at an $19^0$16' North latitude and $76^0$74' East latitude and 409 m above mean sea level. The climate of the region is subtropical one and the region comes under assured rainfall zone with an average annual rainfall of 700 to 885 mm mostly received in about 70 days during June to September. On seasonal basis, it oscillates from humid to sub humid in monsoon, sub humid to semi-arid during post-monsoon and hot and dry in summer. The mean daily maximum temperature varies from 29.1°C in December to 25.4°C in May. The relative humidity ranges from 11 to 90 per cent. Normally, the summer is hot and general dryness persists throughout the year.

Methodology

This study was conducted at Cattle Cross Breeding Project (C CBP), Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The research work was conducted during 01 March 2017 to 28 February 2018 for a period of 52 weeks. The data were classified in accordance with day and season. The readings of climatic attributes in cattle shed was recorded twice in a day by using wet and dry bulb thermometer and the data of temperature, humidity, evapotranspiration, sunshine hours, wind velocity of surrounding environment was taken from meteorological observatory at the university campus which is situated in the vicinity of this farm, to investigate the seasonal variations of milk from Deoni cows during summer, rainy and winter season.

Milk sampling

Cows were milked twice daily at (5.30 am) and at (4 pm). Milk samples were collected early morning at milking time (6:30 am) in clean plastic bottles (60 ml). After thoroughly mixing for getting homogeneous sample, they were immediately transferred to laboratory for analysis at the temperature of air conditioned room. The time between sampling and analysis did not exceed one hour. The milk samples of Deoni cows were taken twice a week at Monday and Thursday in order to get a strictly 7-d interval.

Chemical analysis of milk sample

Fat percentage determination

Fat percentage determination was done by using the Gerber's method (ISI, 1958).

SNF Percentage Determination

The SNF percentage determination was, done by using lactometer. Calculated solids-not-fat (SNF) content by using the given formulas.

$$\% \text{ SNF} = \text{CLR} / 4 + (0.25\times \text{ fat } \%) + 0.44 \quad \text{(ISI Formula)}$$

Where,
CLR = Corrected lactometer reading,
(Corrected lactometer reading = LR + CF),
LR = Lactometer reading,
CF = Correction factor.

Determination of Temperature Humidity Index (THI)

The climatograph based on daily average ambient temperature and humidity is commonly used for calculating the index to differentiate among location on the basis of physical environment. The index which combines these two climatic factors is temperature humidity index (THI) which is calculated according to National Research Council (1971) as follows: (Annonymous, 1971)

$$\text{THI} = 0.72 (\text{dbt°C} + \text{wbt°C}) + 40.6$$

Where,
dbt°C = dry bulb temperature (°C)
wbt°C = wet bulb temperature (°C)
Determined THI values were used to identify heat stress and to examine the monthly variation of THI.

Statistical Method

The data on milk composition (Milk fat and SNF) was subjected for statistical analysis by the method of correlation and regression analysis given by Snedecor and Cocharan (1967). After assessment of variability the data were subjected for the study by the method of correlation and regression analysis.

$Y= a+ b1\ x1 +b2\ x2 +b3\ x3 +b4\ x4 + b5\ x5 +b6\ x6 +b7\ x7 + uij$

where, Y is dependent variable; x is independent variables; a is constant; b is coefficient of x, x1 is max. temp, x2 is min. temp, x3 is max. humidity, x4 is min humidity, x5 evapotranspiration, x6 sunshine hours, x7 is wind velocity and x8 is THI and uij is error term. This multiple regression equation describes an average relationship between dependent and independent variable, which is used to predict the dependent variables. The variability of model was tested with the help ofcoefficient of multiple regressions (R2). The significance of R2 was tested with 'F' test and significance of individual partial regression coefficient was tested with student't' test.

Results and discussion

It is evident from the table 1 that the mean maximum and minimum temperature of whole period is 34 $\pm$ 0.22 and 18.6 $\pm$ 0.30 ^{0}C, respectively. Maximum humidity and minimum humidity of whole period is 73 $\pm$ 0.83 per cent and 38 $\pm$ 1.16 per cent, respectively. Evapotranspiration, sunshine hours, wind velocity and THI value is 6.4 $\pm$ 0.17, 7.7 $\pm$ 0.14 hrs., 4 $\pm$ 0.08 km/hr. and 76 $\pm$ 0.29, respectively. It was observed that average fat percentage was 3.57 $\pm$ 0.016 per cent of Deoni cattle and SNF percentage of Deoni cattle was 8.55 $\pm$ 0.008 per cen. From the Table 1 it is observed that with increase in temperature, evapotranspiration, sunshine hours and THI fat percentage was decreases. It was also observed that maximum humidity and sunshine hours SNF percentage was decreases. It was also found that a sunshine hour was inversely correlated with fat percentage and SNF percentage.

Table 1: Mean values and correlation coefficients of climatic attributes with milk fat percentage and SNF percentage in Deoni cattle

Sr. No.	Variables	Fat		SNF	
		Average value with SE(±)	Correlation coefficient (r)	Average value with SE(±)	Correlation coefficient(r)
1	Max. temp. (X_1)	34 ± 0.22	-0.060^{NS}	34 ± 0.22	-0.311**
2	Min. temp. (X_2)	18.6 ± 0.30	-0.645**	18.6 ± 0.30	-0.758**
3	Maxi. Hum.(X_3)	73 ± 0.83	-0.210*	73 ± 0.83	0.066^{NS}
4	Mini. Hum. (X_4)	38 ± 1.16	-0.503**	38 ± 1.16	-0.292**
5	Evpt. (X_5)	6.4 ± 0.17	-0.005^{NS}	6.4 ± 0.17	-0.351**
6	Sunshine Hrs.(X_6)	7.7 ± 0.14	0.435**	7.7 ± 0.14	0.254**
7	Wind velocity (X_7)	4.0 ± 0.08	-0.349**	4.0 ± 0.08	-0.514**
8	THI (X_8)	76 ± 0.29	-0.537**	76 ± 0.29	-0.734**

Fat: 3.57 ± 0.016 SNF: 8.55 ± 0.008 *Significant at 0.05 per cent **Significant at 0.01 per cent NS= non-significant

It was observed that minimum temperature, maximum humidity, wind velocity and THI indicating negative significant association with fat percentage, while maximum temperature indicating negative non-significant association with fat percentage, All the climatic variables together accounted for 58.20 per cent variation in fat percentage. R^2 value did not reach the level of significant for the fat percentage. Gantner *et al.* (2011) [4] observed that absence of heat stress conditions during autumn and winter season also characterize all three regions. Highly significant (P<0.01) decrease of daily milk yield as well as of daily fat and protein content due to enhanced THI was observed in all cows regardless the parity class and in all three climatic regions.

Table 2: Climatic factors contributing the variation in milk fat percentage and SNF percentage of Deoni cattle

Sr. No.	Variables	Fat			SNF		
		Estimated regression coefficient	SEof (b)	t value	Estimated regression coefficient	SE of (b)	t value
1	Max. temp. (X_1)	-0.0091	0.0064	-1.410^{NS}	0.0044	0.0026	1.667^{NS}
2	Min. temp. (X_2)	-0.0143	0.0051	-2.752**	-0.0080	0.0021	-3.750**
3	Maxi. Hum.(X_3)	-0.0078	0.0016	-4.721**	-0.0046	0.0006	-6.736**
4	Mini. Hum. (X_4)	-0.0017	0.0014	-1.182^{NS}	-0.0002	0.0005	-0.459^{NS}
5	Evpt. (X_5)	0.0044	0.0103	0.430^{NS}	-0.0239	0.0042	-5.659**
6	Sunshine Hrs.(X_6)	0.0081	0.0059	1.372^{NS}	0.0045	0.0024	1.853^{NS}
7	Wind Velocity(X_7)	-0.0175	0.0080	-2.164*	-0.0089	0.0003	-2.685**
8	THI (X_8)	-0.0226	0.0045	-4.946**	-0.0105	0.0018	-5.612**

R^2 = 0.582 F value = 61.90 R^2 = 0.697 F value = 102.32 *Significant at 0.05 per cent **Significant at 0.01 per cent NS= non-significant

With regard to SNF percentage minimum temperature, maximum humidity, minimum humidity, evapotranspiration, wind velocity and THI indicating negative significant association with SNF percentage, while minimum humidity indicating negative non-significant association while maximum temperature and sunshine hours shows positive non-signification association with SNF percentage. All the climatic parameters together accounted 69.70 per cent variation in SNF percentage. R^2 value did not reach the level of significance indicate effect of climatic parameters on SNF percentage in Deoni cattle. Reyad *et al.* (2016) [5] observed that the effect of heat stress on milk yield and milk compositions of Holstein Friesian crossbred (HF) dairy cows. The highest THI was found in July which indicated higher heat stress during this month. The compositions of milk such as total solids (TS), solids-not-fat (SNF), fat, protein, lactose, and ash also differed significantly (p<0.01). The highest values (%) of TS, SNF, fat, protein, lactose and ash content of milk were found in October as 12.63, 8.80, 3.83, 3.69, 4.39 and 0.72, respectively and lowest values (%) were in July as 12.20, 8.50, 3.71, 3.50, 4.30 and 0.69, respectively due to the high THI value. From these results, it is concluded that heat stress has strong effect on milk yield and milk composition of HF cows in Bangladesh.

Conclusion

The above findings indicated that Deoni cows were less sensitive to climatic changes on their fat and SNF percentage. That may be due to their adaptability with the environment as they are originated & developed in this environment. The sunshine hours was a positive relation with decrease in fat percentage and SNF percentage, also temperature and humidity related parameter found to have as negative relationship with milk fat and SNF percentage.

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