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Transition in normal milk constituents during different seasons in red kandhari cows

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Abstract
The study was undertaken on fourteen adults lactating Red Kandhari cattle at Livestock Farm Complex, College of Veterinary & Animal Sciences, Parbhani to observe the effect of different seasons on normal milk components. All the procedures were approved by institutional animal ethics committee and animals were kept in identical managemental conditions. Milk was collected every fifteen days, while recording of environmental variables was scheduled at weekly intervals (14:00 hrs). Dry bulb temperature, wet bulb temperature and THI were maximum during summer, while wind speed was highest in winter as compared to other seasons (P<0.05). Milk fat decreased significantly (P<0.05) in the summer season, but no variation was recorded for SNF, protein, lactose and salt. Only wind speed was negatively correlated with all milk constituents, except for fat. The study indicates better adaptability, resiliency and optimum production performance of indigenous red kandhari cow, during different environmental conditions.

Keywords: red kandhari cow, seasons, milk components, adaptability, optimum production

Introduction
The demand for all animal products in ever increasing with the growth of the human population. It is predicted that demand for animal origin products will double by mid 21st century [1]. This maximum production from livestock will require optimum nutrition and better managemental practices, with protection from adverse climate. Another major constraint is the harsh tropical and subtropical hot environmental, which is aggravating progressively due to global warming and climate change phenomenon's. Not only high yielding cattle, but also moderate yielders are affected due to harsh climate and heat stress.
Climate change will directly and indirectly alter our production systems affecting crops, water, land, pests and diseases ultimately increasing the cost of production and reducing animal welfare [2]. Heat stressed cattle display various behavioral, physiological and metabolic acclimatory and acclimatization responses. Failing to dissipate excess body heat, different metabolic disturbances arise, leading to decreased production and sub-optimum health [3]. There are several studies, comparing the effects of environmental conditions and heat stress on livestock [4, 5, 6]. Both short term and long-term heat stress have shown an adverse impact on total and average milk yield and milk components [7]. A study has predicted heat stress associated losses by 1.7 billion and $2.2 billion, by the year 2050s and 2080s, respectively [8].
Although, the adaptability and resilience to heat stress and harsh environment of indigenous cattle breeds are comparatively better as compared to exotic cattle, still sustained unfavorable climatic conditions are shown to alter physiology, metabolism, decrease production performance and milk yield and quality [9, 10, 11]. With this background, the study was planned to understand the transition in milk constituents in red kandhari cows during different seasons. Most of the previous studies have noted changes in milk constituents, only during any two seasons or for a shorter duration. There is a need to evaluate the transition in milk components over all seasons, to clearly understand the effect of high environmental temperatures and THI during prolong summer, which is very common in central regions of Indian sub-continent.

Materials and Methods
Experimental animals, treatments and sampling
The study was conducted for one year (2019-2021), on 14 adults red kandhari cattle between 3-4 parity [age: > 3 yrs; body weight: > 250 kg] at a livestock farm complex [LFC], College of Veterinary & Animal Sciences, (MAFSU), Parbhani to observe the seasonal transition in normal milk components.

All the animals were kept in loose housing open paddock system and milked twice in an animal shed. Feed and ad libitum water as per the requirement were provided throughout the experimental period [12]. Milk samples were collected fortnightly from all animals in the morning and analyzed within two hours of collection. Data was collected for three seasons viz, winter (Mid-November, 2019 – Mid-February, 2020), summer (Mid -February – Mid-September, 2020) and monsoon (Mid-September – Mid-November, 2020). While, all the meteorological variables were recorded exactly at 14:00 hrs, every week during the study.

Analysis

Milk samples were analyzed for fat %, solid not fats % [SNF], protein %, lactose % and salt % on an automatic milk analyzer [Lactosure]. A multifunctional fully automatic anemometer [Testo make] was used for recording the dry bulb temperature (°C), wet bulb temperature (°C) and wind speed (m/sec), respectively. Reading was only taken after maximum numerical values were reached (in one minute). While, solar intensity (LUX) was recorded by using automatic luxmeter [Testo make], as the maximum value after one minute. The dry bulb and wet bulb temperatures were used for estimation of temperature humidity index [THI], by using the following standard formula,

$$THI=0.72 (Wb + Db) + 40.6$$

Statistical analysis

Data were analyzed on SPSS 20.00 software [13] by one way analysis of variance model and indicated by their probability value (*P*). Differences among treatments were determined using Tukey's *b* test and indicated by the superscripts $^{a, b, c, d}$. While, relations between environmental variables were estimated by *Pearson's correlation*, indicated by *r* value. All data are presented as SEM (standard error of means) and significance was reported at $P<0.05$.

Results

Average environmental conditions during the study are presented in Table 1. Maximum dry bulb, wet bulb temperature and THI were observed during the summer season ($P<0.05$) as compared to winter and monsoon, respectively. While, wind speed was maximum during winter, then summer and monsoon seasons ($P<0.05$). However, we recorded no notable difference ($P>0.05$) for solar intensity during the experimental duration.

Table 1: Average environmental conditions during different seasons

Variable	Winter	Summer	Monsoon	SEM	*P*
Db (°C)	31.96^{a}	35.46^{b}	30.80^{a}	0.548	0.000
Wb (°C)	22.19^{a}	25.69^{b}	25.14^{b}	0.471	0.003
WS (m/s)	1.89^{b}	1.19^{a}	0.85^{a}	0.130	0.003
SI (LUX)	55202.85	56578.75	51049.00	3103.614	0.760
THI	79.59^{a}	84.63^{b}	80.88^{a}	0.571	0.000

*Different superscripts $^{a, b, c, d}$ indicate a significant difference ($P<0.05$) within rows, for a variable; **Db=dry bulb temperature, Wb=wet bulb temperature, WS=wind speed, SI=solar intensity, THI=temperature humidity index

The seasonal changes in milk constituents are presented in Table 2. Only significant variation was seen for milk fat %, which decreased ($P<0.05$) during summer as compared to other seasons. While, SNF, protein, lactose and salt were lower ($P>0.05$) in summer and monsoon as compared to winter.

Table 2: Variation in milk normal constituents (%) in red kandhari cattle during different seasons

Variable	Winter	Summer	Monsoon	SEM	*P*
Fat	5.18^{b}	4.24^{a}	5.05^{b}	0.082	0.000
SNF	8.46	8.41	8.40	0.047	0.899
Protein	3.62	3.08	3.04	0.111	0.141
Lactose	4.61	4.57	4.57	0.025	0.853
Salt	0.65	0.64	0.64	0.004	0.647

*Different superscripts $^{a, b, c, d}$ indicate significant difference ($P<0.05$) within rows, for a variable; **SNF=solid not fat

It can be seen from Table 3, that of all the meteorological variables only WS was negatively correlated ($P<0.05$) with SNF, protein, lactose and salt except for fat (r=-.420**, r=-.430**, r=-.420**, r=-.363*, respectively). Also, some significant correlations were noted for salt with fat, SNF, protein and lactose (r=.346**, r=.897**, r=.190**, r=.892**).

Table 3: Correlation between environmental variables and milk components in red kandhari cattle

	Fat	SNF	Protein	Lactose	Salt	Db	Wb	WS	LUX	THI
Fat	1									
SNF	.357**	1								
Protein	.054	.183**	1							
Lactose	.355**	.996**	.181**	1						
Salt	.346**	.897**	.190**	.892**	1					
Db	-.094	-.075	-.076	-.072	-.068	1				
Wb	.041	.210	.223	.218	.200	.207	1			
WS	-.225	-.420**	-.430**	-.420**	-.363*	.088	-.261	1		
LUX	.210	.129	.120	.128	.128	.501**	-.003	.218	1	
THI	-.041	.073	.080	.080	.072	.814**	.737**	-.094	.345*	1

*Correlation is significant at the 0.05 level, **Correlation is significant at the 0.01 level;
SNF=solid not fat, Db=dry bulb temperature, Wb=wet bulb temperature, WS=wind speed, SI=solar intensity, THI=temperature humidity index

Discussion

Different environmental conditions will always influence animal physiology and metabolism. The effect of the environment is more profound in tropical and subtropical regions like India. In our study the cows were kept in a loose housing system with adequate shade. The red kandhari is a native cattle breed, well acclimated and adapted to local environmental conditions. Also, these are a notable difference

in THI tolerance amongst indigenous and crossbred cattle [14]. Over the decades, the effect of heat stress on animal physiology, production, reproduction and welfare is studied comprehensively [15, 16, 4]. Also, many authors have studied the effect of different seasons and particularly heat stress on milk production and changes in milk constituents [9, 7, 11]. The animal's response varies with the duration of stress, breed, preconditioning of the animal, stage of production, pregnancy, age, etc.

In this study high environmental temperatures, with low wind speed and corresponding high THI were noted during the summer season as compared to winter and monsoon. These conditions compromise the normal channels of heat dissipation, resulting in the accumulation of heat load, predisposing the animal to heat stress [17]. The THI values of 84.63 in summer, then 80.88 in monsoon and 79.59 in winter, clearly indicate heat exposure and heat stress in red kandhari cows, particularly during summers and monsoon seasons.

The animals respond by making several physiological, metabolic and behavioral alterations to maintain homeothermy, but at the cost of growth or production or reproduction [4, 11]. Already the lactating animals are under tremendous production pressure and this coupled with an inability to loose heat quickly, makes them more susceptible than dry cattle, to heat stress [18]. This metabolic transition diverts energy for thermoregulation, instead of production resulting in reduced milk yield or alterations in milk components [19]. Similar, metabolic turnover during summer season, might have resulted in significant reduction in milk fat in red kandhari cows and also fat is the most variable component of milk in different species. Our results are corroborated by observations of reduction in milk fat during the summer season in heat stressed cattle [19, 20, 21, 22]. However, we observed no variation for other milk components, like, SNF, protein, lactose and salt during different seasons which might be due to optimum mammary production, metabolism and turnover for other milk components in cows. This indicates the superior adaptability of native cows to adapt to varying environmental conditions as compared to crossbreds or exotic cattle [23].

Meteorological variables like, temperature, humidity, solar intensity, wind speed, precipitation and their combination i.e., THI all influence animals heat dissipation capacity and thus physiology and metabolism. Although, dry bulb temperature, wet bulb temperature, solar intensity and THI had no significant correlation (Table 3), wind speed was negatively correlated with milk constituents. This reflects the importance of heat dissipation channels employed by animals to maintain homeothermy [24, 4]. Another reason for the lack of variation for milk constituents, except for fat in different seasons can be marginal production capacity (2-5 L) of the red kandhari breed. It is well known that high yielding cattle are more susceptible to adverse climatic conditions [25, 26, 27].

Conclusion

Our study established the adaptability and thermotolerance of native over crossbreds or exotic cattle. High ambient temperature, wind speed, solar intensity and THI are some of the variables that constantly challenge animals homeothermy, enforcing different thermoregulatory mechanisms. If animals are provided adequate nutrition, water and shade they can maintain optimum heat balance and continue production efficiently. Loose housing system with protective provisions for environment and better management, might be the solution to alleviate heat stress, resulting in better production and welfare in milch animals.

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