ENVIRONMENTAL FACTORS AFFECTING LACTATION MILK YIELD OF JAFFARABADI BUFFALOES IN AN ORGANIZED FARM OF GUJARAT

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ABSTRACT

The study was undertaken to evaluate the effect of different macro climatic variables on lactation milk yield of Jaffarabadi buffaloes. Milk data of 158 Jaffarabadi buffaloes with 476 lactation records and the meteorological data over a period of 24 years (1987 to 2010) were obtained from Livestock Research Station, Junagadh Agricultural University, Junagadh, Gujarat, India. The influence of environmental factors on lactation milk yield was non-significant (P>0.05). It was observed that lactation milk yield was highest (1962.53±176.73) among the Jaffarabadi buffaloes calved during winter season as compared to rainy (1674.37±268.49) and summer season (1566.52±108.68). All the climatic variables considered in the study accounted for 4.48%, 32.01% and 29.36% direct variation on lactation milk yield in winter, summer and monsoon season, respectively, as verified by the value of coefficient of determination (R2). This research indicates that Jaffarabadi buffaloes were not much sensitive to seasonal changes on their lactation milk yield. The meteorological observation during the period of study confirmed that there was high value of THI in eight months (March to October) in a year, but it didn't show any significant effect of lactation milk yield which suggests that most buffaloes are with neutral effects of heat stress or any other macro or micro environmental changes in this region and it suggest this buffalo breed can perform well in round the year. This analysis revealed that this buffalo breed having good genetic potential to perform in any condition.

Keywords: *Bubalus bubalis*, buffalo, lactation milk yield, environmental variables, THI, heat stress

INTRODUCTION

Climatic risks associated with global warming are increasing day by day. Recent observation show increase in temperature, hot day, hot nights and hot waves, increasing frequency of heavy precipitation events of increased snow melt and rise in sea level by 0.18 to 0.59, changes in seasonal distribution of precipitation within the various regions. Warming effects will shift climatic zone and rainfall pattern, are some examples of climatic extremes (Gadekar, 2005). Animal's health and productivity is closely interacted with environment in which they perform. Thermal factors

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are important components of physical environment as they are directly responsible to animal comfort and which includes environmental temperature, humidity, air movement, solar radiation and precipitation. These varied environmental factors influence the ability of animal to produce (Singh and Mishra, 2007).

Heat stress results from the animal's inability to dissipate sufficient heat to maintain homeothermy. As a result, there is an increase in body temperature, which is a term initiate compensatory and adoptive mechanism to establish homeothermy and homeostatic. Heat stress has a negative impact on the livestock production both directly and indirectly.

Buffaloes are more sensitive than cattle to direct solar radiation and ambient temperature because of dark body colour, absence of sweat glands and thick epidermal layer of skin. Due to heat stress buffaloes reduce their milk production with shorter lactation period (Upadhyay *et al*., 2007).

Buffaloes play a major role in Indian dairy industry and contributing about 54% share of milk production. Jaffarabadi is the heaviest of all the Indian breeds of buffaloes. It is also called as Bhavnagri, Gir or Jaffari. The breed is named after the town of Jaffarabad. The main native tract of Jaffarabadi buffalo is Saurashtra region of Gujarat state especially areas in and around Gir forest *viz*., Junagadh, Bhavnagar, Jamnagar, Porbandar, Amreli and Rajkot districts. The breeding tract lies between 20^{o} 5' and 22^{o} 6' N latitude, and between 70^{o} and 72^{o} E longitude. Jaffarabadi buffaloes are good milkers and thrive well on natural grazing. These buffaloes characteristically differ from other breeds mainly in terms of kilo fat. They are very efficient in the conversion of roughages into milk with a high butter fat content. Hence this research is planned to measure variation in production performance due to environmental factors in Jaffarabadi buffaloes.

MATERIALS AND METHODS

Study area and duration

This study was conducted at Department of Animal Genetics and Breeding, College of Veterinary Science and Animal Husbandry, Junagadh Agricultural University, Junagadh, Gujarat, India, which is located between 68 to 72^{o} east longitude and 20 to 24^{o} north latitude and about 60 meters above the mean sea level. The climate is mainly tropical to subtropical. The mean daily maximum temperature varies from 29.4^{o}C in January to 39.4^{o}C in May. The mean daily minimum temperature varies from 10.1^{o}C in January to 26.4^{o}C in May. The relative humidity ranges from 50 to 88.1%. Normally, the summer is hot and general dryness persists throughout the year.Systematic record of buffalo herd in respect to daily milk yield, date of calving, Lactation length, dry period, peak milk yield etc. is maintained at this farm. The data of Jaffarabadi buffaloes in respect of above characters in different season for the period of 1987 to 2010 with 476 records of lactation and buffaloes having at least two offspring were selected for analysis. Meteorological data (1987 to 2010) were obtained from the department of meteorology, Junagadh Agricultural University. The complete year was divided into 3 seasons as monsoon (June to September), winter (October to January) and summer (February to May).

Management of experimental animals

The management at this farm were identical as per one of the good organized farm. The daily

routine for milch animals started at 4.30 am. The animals were milked by about 5.30 am to 6.30 am after feeding concentrate mixture. The udders were washed with water and cleaned dry with cloth before milking. The animals were allowed to graze daily except rainy days. The animals were then tied and stall fed with required quantities of dry and seasonal greens. They were again cleaned at 3.30 pm and fed concentrates and milked subsequently at 4.30 pm. New born calves were not separated from their dam at birth as this animals having high mother instinct. The dams remained in barn for the one to five days during which they were provided with green fodder, concentrate diet and transferred to the milking herd afterwards.

All animals were routinely checked for any incident of health problem and treatments were given if any abnormality exists. Additionally, animals were regularly vaccinated and dewormed. The milch buffaloes were specially provided with bath under showers in herd.

Determination of temperature humidity index (THI) is a useful and easy way to assess the risk of heat stress. Determined THI values were used to identify heat stress and to examine the monthly variation of THI. THI is calculated according to National Research Council (1971) as follows:

$$THI = 0.72 (dbt^{o}C + wbt^{o}C)+40.6$$

Where, $dbt^{o}C$ = dry bulb temperature (^{o}C)

$wbt^{o}C$ = wet bulb temperature (^{o}C)

Statistical analysis

To investigate the effect of environmental variables on lactation milk yield the data were analysed by using correlation and multiple regression model. The main environmental variables were also compiled as monthly minimum and maximum temperature, average relative humidity, monthly wind speed (km/h) and monthly sunshine (h) as well as THI. Data were analysed by using the statistical analysis package of R software 3.3.0 version. The following regression model was utilized to study the effect of different independent variables (Environmental factors) on lactation milk yield.

$$Y = a + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + b6X6 + uij$$

Where, Y = dependent variable (Lactation Milk Yield)

X = independent variables (Environmental Factors)

a = constant

b = coefficient of x

uij = error

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 of coefficient of multiple regressions (R^2). The significance of R^2 was tested with 'F' test and significance of individual partial regression coefficient was tested with't' test. To determine the role various environmental factors in the variation of lactation milk yield, stepwise regression was undertaken based on the contribution of different environmental variables. Basically, regression helps to estimate the functional relationship between the independent and dependent variables.

RESULTS AND DISCUSSION

Environmental variables during the period of study

The average monthly environmental variables *viz*., maximum and minimum temperature, average relative humidity, sunshine hours, wind speed and temperature humidity index during the period of study (1987 to 2010) are presented in Table 1 and Figure 1. The environmental condition observed in the table was clearly indicated that the climate of the area under this study was found mainly tropical to subtropical.

Effect of environmental variables on lactation milk yield of Jaffarabadi buffaloes in winter season

Generally winter climate condition favours the milk production in animal due to pleasant climate and availability of quality fodder. Average lactation milk yield was recorded as 1962.53±176.73 lit in winter season for the animal under study. These indicated that lactation milk yield in Jaffarabadi buffaloes was more in winter season than rainy and summer season, confirming the general consideration of suitability of Jaffarabadi buffaloes under cold climate which we can also see in other dairy animals. It is shown from Table 2 that environmental factors except wind speed and sunshine hour shows positive association with lactation milk yield in Jaffarabadi buffaloes.

All the considered environmental variables accounted for 4.48% variation in lactation milk yield. However, R^2 value does not exceed the level of significance for lactation milk yield indicating that it didn't influenced by environmental factors. Bajwa *et al.* (2004) in Sahiwal and Kamble *et al.* (2015) in Murrah buffaloes observed year and season of calving both significantly ($P<0.01$) affected milk yield.

Effect of environmental variables on lactation milk yield of Jaffarabadi buffaloes in summer season

Summer climate condition at location of study was hot dry. Average lactation milk yield was recorded as 1566.52+108.68 lit in summer season. It was noted in this study that the maximum and minimum temperature established negative association with lactation milk yield in summer season. Correlation coefficient values for THI and

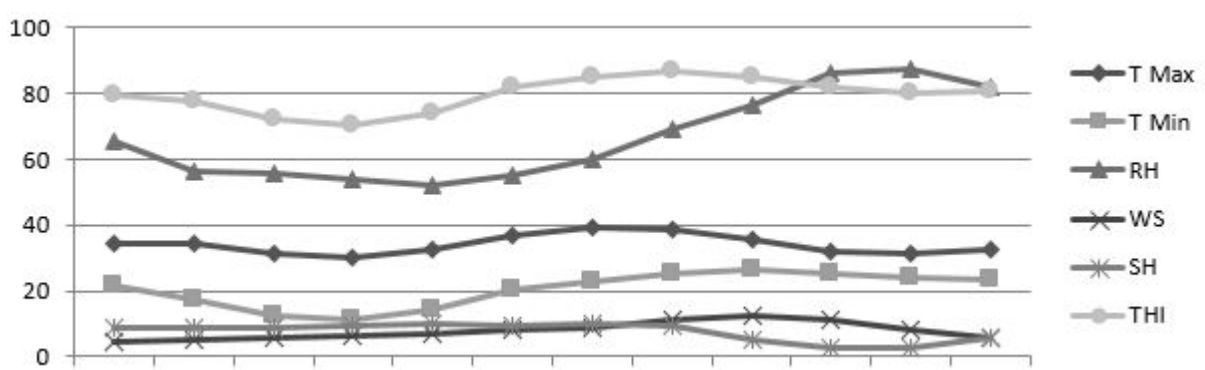

Figure 1. Month wise averages of environmental components (1987 to 2010).

humidity were non-significant. Sunshine hour alone has contributed positive correlation with milk yield indicating contribution of this factor in variation of milk yield than those of other environmental factors during summer season. In general lactation milk yield was decrease with increase in any of the environmental factor except sunshine hour in summer season. Afzal *et al.* (2007); Javed *et al.* (2009) observed similar results in Nili-Ravi buffaloes. Kamble *et al.* (2015) was reported same finding in his study with Murrah buffalo breed.

From Table 3, it is seen that all the considered environmental variables accounted for 32.01% variation in lactation milk yield. However R^2 value does not exceed the level of significance for lactation yield indicating consistent effect of environmental factors on lactation milk yield. Afzal *et al.* (2007); Hyder *et al.* (2007) observe that buffaloes calving in spring showed highest and those calving in summer showed lowest milk yield, similar finding was reported by Kamble *et al.* (2015) in Murrah buffalo. In contrast Thokal *et al.* (2004) reported that buffaloes calved during summer season had highest milk yield.

Effect of environmental variables on lactation milk yield of Jaffarabadi buffaloes in monsoon season

Average lactation milk yield was recorded as 1674.37±268.49 lit in monsoon season. From Table 4 we can see that the different environmental factors didn't have any significant effect on lactation milk yield but relative humidity having negative correlation with lactation milk yield.

It indicate that no environmental changes during monsoon season affect the lactation yield i.e. no relative changes in lactation milk yield of Jaffarabadi buffalo with increase or decrease in ambient temperature and humidity level. Shinde and Taneja (1986) in river buffaloes and Kamble *et al.* (2015) in Murrah buffaloes were reported that temperature and humidity have largest variation in daily milk yield which was contrary to present study findings.

All the considered environmental variables accounted for 29.36% variation in lactation milk yield. The value of coefficient of determination (R^2) also revealed non-significant level for lactation milk yield. The neutral association of ambient temperature with lactation milk yield indicates that lactation milk yield didn't show any relative change with increase or decrease in ambient temperature in monsoon season for Jaffarabadi buffalo breed.

CONCLUSION

This research indicates that Jaffarabadi buffaloes were not much sensitive to seasonal changes on their lactation milk yield. The meteorological observation during the period of study confirmed that there was high value of THI in eight months (March to October) in a year, but it didn't show any significant effect on lactation milk yield which suggests that most buffaloes are with neutral effects of heat stress or any other macro or micro environmental changes in this region and it suggest this buffalo breed can perform well in round the year. This analysis revealed that this buffalo breed having good genetic potential to perform in any condition.

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Table 1. Average meteorological data during the period of study (1987-2010).

Month	T°C		RH% (Avg.)	WS (km/h)	SH (h)	THI
	Max	Min				
Jan	30.02	10.92	53.6	6.46	9.3	70.08
Feb	32.45	14.1	52.25	6.78	9.73	74.12
Mar	36.96	20.16	54.8	8.08	9.62	81.73
Apr	39.02	22.58	60.2	8.64	9.96	84.95
May	38.67	25.5	69.17	11.07	9.55	86.80
Jun	35.34	26.22	76.4	12.4	5.12	84.92
Jul	31.92	25.14	86.2	11.02	2.62	81.68
Aug	31.18	23.85	87.25	7.93	2.7	80.22
Sep	32.76	23.16	82.2	5.5	5.9	80.86
Oct	34.33	21.65	65.25	4.65	8.68	79.34
Nov	34.24	17.3	56	4.9	8.7	77.71
Dec	31.44	12.36	55.8	5.52	8.52	72.14
Average	34.03	20.25	66.59	7.74	7.53	79.54

Table 2. Correlation and regression coefficients for lactation milk yield in Jaffarabadi buffaloes during winter season.

Variable	Means±SE	LMY (1674.37±268.49)			
		r	b	SE of b	t-value
Max temp (°C)	32.51±0.67	0.12	0.27	1.59	0.17
Min Temp (°C)	15.56±1.55	0.38	0.38	0.65	0.58
RH% (Avg.)	57.66±1.64	0.74	0.69	0.44	1.57
WS (km/h)	5.38±0.25	-0.29	-1.77	4.05	0.44
SH (h)	8.80±0.11	-0.37	-5.18	9.28	-0.56
THI	74.82±1.40	0.21	0.23	0.76	0.30

*Significant at 0.05%, **Significant at 0.01%, ***Significant at 0.001% (r = Correlation coefficient, b = Regression coefficient, Max temp. (°C) = Maximum temperature, Min temp. (°C) = Minimum temperature, RH% (Avg.) = Relative humidity, SH (h) = Sunshine hours, WS (km/hr) = Wind speed, THI = Temperature humidity index, LMY = Lactation milk yield)

Table 3. Correlation and regression coefficients for lactation milk yield in Jaffarabadi buffaloes during summer season.

Variable	Means±SE	LMY (1674.37±268.49)			
		r	b	SE of b	t-value
Max temp (°C)	36.78±0.96	-0.55	-0.88	0.95	-0.93
Min temp (°C)	20.59±1.53	-0.57	-0.56	0.58	-0.97
RH% (Avg.)	59.11±2.37	-0.31	-0.20	0.43	-0.46
WS (km/h)	8.64±0.57	-0.48	-1.29	1.67	-0.77
SH (h)	9.72±0.06	0.58	15.62	15.55	1.00
THI	81.90±1.77	-0.56	-0.49	0.50	-0.97

*Significant at 0.05%, **Significant at 0.01%, ***Significant at 0.001% r = Correlation coefficient, b = Regression coefficient, Max temp (°C) = Maximum temperature, Min temp (°C) = Minimum temperature, RH% (Avg.) = Relative humidity, SH (h) = Sunshine hours, WS (km/h) = Wind speed, THI = Temperature humidity index, LMY = Lactation milk yield

Table 4. Correlation and regression coefficients for lactation milk yield in Jaffarabadi buffaloes during monsoon season.

Variable	Means±SE	LMY (1674.37±268.49)			
		r	b	SE of b	t-value
Max temp (°C)	32.80±0.57	0.58	1.56	1.53	1.02
Min temp (°C)	24.59±0.43	0.37	1.34	2.33	0.58
RH% (Avg.)	83.01±1.55	-0.60	-0.59	0.56	-1.06
WS (km/h)	9.21±0.98	0.29	0.45	1.06	0.42
SH (h)	4.09±0.53	0.28	0.80	1.96	0.41
THI	81.92±0.66	0.54	1.26	1.38	0.91

*Significant at 0.05%, **Significant at 0.01%, ***Significant at 0.001%
r = Correlation coefficient, b = Regression coefficient, Max temp (°C) = Maximum temperature, Min temp (°C) = Minimum temperature, RH% (Avg.) = Relative humidity, SH (h) = Sunshine hours, WS (km/h) = Wind speed, THI= Temperature humidity index, LMY = Lactation milk yield

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