

## Changes in haematocrit and some serum biochemical profile of Sahiwal and Jersey × Sahiwal cows in tropical environments

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### ABSTRACT

A study was conducted on the biochemical constituents of pure Sahiwal and Jersey × Sahiwal crossbred animals in tropical conditions. Six animals were selected from each category of Sahiwal heifers, Sahiwal cows and Jersey × Sahiwal crossbred cows. The biochemical constituents of the above animals were recorded during the experimental period of 21 days. The haematocrit values (%) of Sahiwal heifers, Sahiwal cows and Jersey × Sahiwal cows were ranged from  $29.17 \pm 1.22$  to  $68.00 \pm 1.06$ ,  $31.00 \pm 1.46$  to  $67.00 \pm 1.06$  and  $31.17 \pm 1.17$  to  $75.83 \pm 0.59$ , respectively. A non-significant difference was observed in haematocrit values of Sahiwal heifers and cows, whereas a significant ( $P < 0.01$ ) variation was recorded for Jersey × Sahiwal crossbred cows. The serum glucose, urea and creatinine levels (mg/dL) of Sahiwal heifers, Sahiwal cows and Jersey × Sahiwal cows ranged from  $61.90 \pm 1.34$  to  $97.32 \pm 0.63$ ,  $58.61 \pm 1.20$  to  $96.90 \pm 0.65$  and  $59.26 \pm 0.58$  to  $113.33 \pm 0.71$ ,  $11.72 \pm 0.94$  to  $47.21 \pm 0.64$ ,  $11.70 \pm 0.65$  to  $45.44 \pm 0.42$  and  $14.00 \pm 0.58$  to  $63.99 \pm 0.41$  and  $1.25 \pm 0.07$  to  $9.81 \pm 0.13$ ,  $1.29 \pm 0.09$  to  $9.90 \pm 0.17$  and  $1.43 \pm 0.10$  to  $16.18 \pm 0.15$ , respectively. The average serum glucose values were significantly ( $P < 0.01$ ) different among all the experimental animals during adaptability. The serum calcium and phosphorous levels (mg/dL) of Sahiwal heifers, Sahiwal cows and Jersey × Sahiwal cows ranged from  $10.59 \pm 0.29$  to  $27.17 \pm 0.29$ ,  $10.84 \pm 0.27$  to  $26.61 \pm 0.46$  and  $10.45 \pm 0.33$  to  $36.76 \pm 0.71$ ,  $5.85 \pm 0.05$  to  $18.91 \pm 0.21$ ,  $5.94 \pm 0.08$  to  $18.87 \pm 0.12$  and  $5.88 \pm 0.10$  to  $20.80 \pm 0.13$ , respectively. A non-significant difference was observed in serum calcium and phosphorous levels for Sahiwal heifers and Sahiwal cows, whereas a significant ( $P < 0.01$ ) variation was recorded for Jersey × Sahiwal crossbred cows in relation to adaptability. The present study concludes that haematocrit, glucose, urea, creatinine, calcium, phosphorous

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levels of the Sahiwal cows were significantly ( $P < 0.01$ ) higher during the first three days of the experimental period and later declined to the normal range of the species. In the case of Jersey × Sahiwal crossbred cows, higher levels of haematocrit and the above serum constituents were observed for a period of six days, which later declined to reach the normal range of the species in tropical environments.

**Key words:** biochemical constituents, Sahiwal and Jersey × Sahiwal cows

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### Introduction

An important factor that affects the productive and reproductive performance of crossbred cows is climate, which influences the adaptability of dairy cows to a particular environment, mostly tropical conditions. Exposure to a tropical environment affects both the behaviour and physiology of cattle and can impair animal welfare. Increased heat load, caused by a combination of air temperature, relative humidity, wind velocity and solar radiation, increases body temperature and respiration rate, and can reduce feed intake and milk production (HAHN, 1999; OMINSKI et al., 2002; WEST, 2003). Excessive heat load affects the animal's thermoregulatory mechanism, creates a stressful condition and negatively affects the breeding performance in dairy cattle, by reducing fertility and in extreme cases results in death.

Therefore the evaluation of the biochemical profile of indigenous and crossbred cattle in tropical environmental conditions is an essential prerequisite for the selection of animals and estimation of production and reproduction efficiency. Hence, the present study was undertaken to study the biochemical constituents of pure Sahiwal and Jersey × Sahiwal crossbred cows in tropical conditions.

### Materials and methods

The study was carried out on eighteen Sahiwal and Jersey × Sahiwal animals maintained at the Dairy Experimental Station, Department of Livestock Production and Management, College of Veterinary Science, Tirupati Andhra Pradesh, India. The laboratory analysis was conducted at the Department of Livestock Production and Management, College of Veterinary Science, Tirupati.

*Topography of the study area.* The institute is situated 182.9 meters above mean seal level at 13.27 °N Latitude and 79.36 °E Longitude. The average annual rainfall is around 900 mm. The climate of the area is typically tropical. The average temperature ranges from 25-45 °C (Annual report, 2010 Regional Agricultural Research Station, Tirupati).

*Selection of animals.* The Sahiwal heifers and cows were purchased from Rohtak. The Jersey × Sahiwal crossbred cows were purchased from Puthalapattu, Thavanampalli and Bangarupalyam mandals of the Chittoor District of Andhra Pradesh, India, from known pedigree.

The biochemical studies were conducted on Sahiwal heifers, cows and Jersey × Sahiwal crossbred cows by selecting six animals from each category. The biochemical constituents of the above animals were recorded and the data was analysed using Completely Randomized Design (CRD).

*Management of animals.* All the animals at Dairy Experimental Station were housed individually under a loose housing system and they were kept in open paddocks with roof over mangers. The nutritional requirement was standardized, as per the ICAR standards. The heifers and cows were fed with green fodder at the rate of 15 and 25 kg respectively. Similarly dry fodder and concentrates were provided to the heifers and cows at the rate of 3.0 and 6.0 kg and 1.5 and 3.0 kg respectively. The animals had free access to fresh and clean drinking water all the time. All types of veterinary aid measures were taken for all animals, which were followed as per farm schedule.

The animals maintained by the farmers under the Progeny Testing Programme were kept under back yard rearing. The animals were allowed for 5-6 hours of grazing and fed ad libitum with dry fodder and green fodder, and 1-2 kg of concentrate feed irrespective of their milk yield.

*Collection of meteorological data.* The information regarding various components of climatic variables was collected from Regional Agricultural Research station, Tirupati, Andhra Pradesh, India. The climatic variables, as experienced during the study period, were temperature, dry bulb temperature, wet bulb temperature, relative humidity, wind speed, sunshine and rainfall.

*Temperature humidity index (THI).* To estimate the comfort and discomfort of the animals, the Temperature Humidity Index was calculated using the following formula:

$$\text{THI} (0.35 \times T_{\text{db}} + 0.65 \times T_{\text{wb}}) \times 1.8 + 32 \text{ (BIANCA, 1962)}$$

Where  $T_{\text{db}}$  : Dry bulb temperature (°C)

$T_{\text{wb}}$  : Wet bulb temperature (°C)

*Blood biochemical profile.* The biochemical constituents of Sahiwal and Jersey × Sahiwal crossbred cows were investigated for a period of 21 days.

*Collection of blood.* Blood samples (2 mL) were collected by puncturing the jugular vein of the experimental animals into sterile vials containing disodium salt of EDTA 2 mg/mL as anticoagulant under aseptic conditions, for estimation of PCV. The blood samples were labelled and brought to the laboratory for further investigation. For estimation of biochemical blood constituents, 10 mL of blood samples were collected from the experimental animals without adding anticoagulant. Serum was separated by centrifugation and transferred into a sterilized plastic vial, and labelled. The serum samples were used immediately for glucose estimation. The samples which were not able to be analysed on the same day of collection were stored at -20 °C until analysed (until 72 hours after collection of blood). Clean glassware, micropipettes of different capacities

and analytical grade chemicals were used in the study. The blood samples were collected from Sahiwal and Jersey × Sahiwal animals daily at 7.00 a.m..

*Haematocrit values.* Haematocrit values (PCV) were measured by the microhaematocrit method, using plain capillary tubes (7 mm × 1 mm) and were read on an Adams microhaematocrit, as per the procedure by JAIN (1986).

*Blood constituents.* The blood constituents like glucose, urea, creatinine, calcium, phosphorus, were studied on a “Prietest Auto Biochemistry Analyser” supplied by Robonik (India) Pvt. Ltd., Navi Mumbai using the reagent kits supplied by Agappe diagnostics Pvt. Ltd., Ernakulam, Kerala.

The data was subjected to analysis of variance (SNEDECOR and COCHRAN, 1994) and the means were compared by Least Square Difference (LSD) test.

## Results

*Haematocrit values (PCV).* The data on average haematocrit (PCV), glucose, urea, creatinine, calcium and phosphorus values in Sahiwal heifers, cows and Jersey × Sahiwal crossbred cows during adaptability are presented in Table 1.

The haematocrit values (L/L) of Sahiwal heifers, cows and Jersey × Sahiwal cows ranged from  $29.17 \pm 1.22$  to  $68.00 \pm 1.06$ ,  $31.00 \pm 1.46$  to  $67.00 \pm 1.06$  and  $31.17 \pm 1.17$  to  $75.83 \pm 0.59$  respectively during their adaptability. The haematocrit values of the Sahiwal heifers and cows were higher during the first three days, and later declined to the normal range of the species, whereas in Jersey × Sahiwal cows higher haematocrit values were observed during the first six days.

A non-significant difference was observed in haematocrit values of Sahiwal heifers and cows, whereas a highly significant ( $P < 0.01$ ) variation was recorded with Jersey × Sahiwal crossbred cows (Table 2).

*Glucose.* The glucose levels (mg/dL) of Sahiwal heifers, cows and Jersey × Sahiwal cows ranged from  $61.90 \pm 1.34$  to  $97.32 \pm 0.63$ ,  $58.61 \pm 1.20$  to  $96.90 \pm 0.65$  and  $59.26 \pm 0.58$  to  $113.33 \pm 0.71$  respectively during their adaptability. The glucose levels of the Sahiwal heifers and cows were higher during the first three days and later declined to the normal range of the species, whereas in Jersey × Sahiwal cows higher glucose levels were observed during the first six days.

The average glucose values were highly significantly ( $P < 0.01$ ) different among Sahiwal heifers, Sahiwal cows and Jersey × Sahiwal cows (Table 2).

*Urea.* The blood urea levels (mg/dL) of Sahiwal heifers, cows and Jersey × Sahiwal cows ranged from  $11.72 \pm 0.94$  to  $47.21 \pm 0.64$ ,  $11.70 \pm 0.65$  to  $45.44 \pm 0.42$  and  $14.00 \pm 0.58$  to  $63.99 \pm 0.41$  respectively during their adaptability. In Sahiwal heifers and cows higher blood urea levels were recorded during the first three days, and they later declined to the normal range of the species, whereas in Jersey × Sahiwal cows higher levels were observed during the first six days.

Table 1. Average biochemical constituents in pure and crossbred animals during adaptability (n = 6)

Animal	Haematocrit (L/L)		
	Minimum	Maximum	Mean ± SE
Sahiwal heifers	29.17 ± 1.22	68.00 ± 1.06	36.30 ± 1.76 <sup>a</sup>
Sahiwal cows	31.00 ± 1.46	67.00 ± 1.06	36.44 ± 1.28 <sup>a</sup>
J × S cows	31.17 ± 1.17	75.83 ± 0.59	41.98 ± 1.19 <sup>b</sup>
	Glucose (mg/dL)		
Sahiwal heifers	61.90 ± 1.34	97.32 ± 0.63	68.93 ± 1.02 <sup>a</sup>
Sahiwal cows	58.61 ± 1.20	96.90 ± 0.65	65.85 ± 1.42 <sup>b</sup>
J × S cows	59.26 ± 0.58	113.33 ± 0.71	72.31 ± 0.96 <sup>c</sup>
	Urea (mg/dL)		
Sahiwal heifers	11.72 ± 0.94	47.21 ± 0.64	17.33 ± 1.00 <sup>a</sup>
Sahiwal cows	11.70 ± 0.65	45.44 ± 0.42	20.47 ± 0.94 <sup>b</sup>
J × S cows	14.00 ± 0.58	63.99 ± 0.41	25.44 ± 0.63 <sup>c</sup>
	Creatinine (mg/dL)		
Sahiwal heifers	1.25 ± 0.04	9.81 ± 0.13	2.18 ± 0.08 <sup>a</sup>
Sahiwal cows	1.29 ± 0.09	9.90 ± 0.17	2.17 ± 0.11 <sup>a</sup>
J × S cows	1.43 ± 0.10	16.18 ± 0.15	3.72 ± 0.10 <sup>b</sup>
	Calcium (mg/dL)		
Sahiwal heifers	10.59 ± 0.29	27.17 ± 0.29	12.42 ± 0.23 <sup>a</sup>
Sahiwal cows	10.84 ± 0.27	26.61 ± 0.46	12.50 ± 0.28 <sup>a</sup>
J × S cows	10.45 ± 0.33	36.76 ± 0.71	14.77 ± 0.35 <sup>b</sup>
	Phosphorus (mg/dL)		
Sahiwal heifers	5.85 ± 0.05	18.91 ± 0.21	7.12 ± 0.10 <sup>a</sup>
Sahiwal cows	5.94 ± 0.08	18.87 ± 0.12	7.19 ± 0.10 <sup>a</sup>
J × S cows	5.88 ± 0.10	20.80 ± 0.13	8.35 ± 0.10 <sup>b</sup>

a, b : Values with different superscripts in a column differ significantly (P<0.01)

Normal range - Haematocrit (L/L) 24-46, Glucose (mg/dL) 45-75, Urea (mg/dL) 6-27, Creatinine (mg/dL) 1-2, Calcium (mg/dL) 9.7-12.4, Phosphorus (mg/dL) 5.6-6.5 (RADOSTITS et al., 2007)

Table 2. ANOVA of haematocrit (PCV), glucose and urea levels in pure and crossbred animals during adaptability

Haematocrit (L/L)						
Source of variation	df	MSS	F-value	S.Ed.	CD 5%	CD 1%
Treatments	62	782.0507	59.4476	--	--	--
Breeds	2	1319.253	100.2831**	0.457	0.8956	1.1771
Days	20	2095.017	159.2528**	1.209	2.3697	3.1144
Interaction	40	98.70747	7.5033**	2.0941	4.1044	5.3943
Error	315	13.1553	--	--	--	--
Total (SS)	377	--	--	--	--	--
Glucose (mg/dL)						
Treatments	62	837.944885	82.7102	--	--	--
Breeds	2	1316.668701	129.9632**	0.4010	0.7860	1.0330
Days	20	2170.665283	214.2578**	1.0610	2.0795	2.7331
Interaction	40	147.648529	14.5738**	1.8377	3.6018	4.7338
Error	315	10.131089	--	--	--	--
Total (SS)	377	--	--	--	--	--
Urea (mg/dL)						
Treatments	62	735.394714	40.5348	--	--	--
Breeds	2	2995.308350	165.1008**	0.5366	1.0518	1.3824
Days	20	1795.291748	98.9561**	1.4198	2.7828	3.6574
Interaction	40	92.450531	5.0959**	2.4592	4.8199	6.3348
Error	315	18.142300	--	--	--	--
Total (SS)	377	--	--	--	--	--

\*\* Significant (P&lt;0.01)

The average blood urea levels were highly significantly (P<0.01) different among Sahiwal heifers, Sahiwal cows and Jersey × Sahiwal cows (Table 2).

*Creatinine.* The serum creatinine levels (mg/dL) of Sahiwal heifers, cows and Jersey × Sahiwal cows ranged from  $1.25 \pm 0.07$  to  $9.81 \pm 0.13$ ,  $1.29 \pm 0.09$  to  $9.90 \pm 0.17$  and  $1.43 \pm 0.10$  to  $16.18 \pm 0.15$  respectively during their adaptability. The haematocrit values of the Sahiwal heifers and cows were higher during the first three days and later declined to the normal range of the species, whereas in Jersey × Sahiwal cows higher haematocrit values were observed during the first six days.

A non-significant difference was observed in serum creatinine levels between Sahiwal heifers and Sahiwal cows, while a highly significant ( $P < 0.01$ ) variation was recorded with Jersey × Sahiwal crossbred cows (Table 3).

Table 3. ANOVA of serum creatinine, calcium and phosphorus levels in pure and crossbred animals during adaptability

Creatinine (mg/dL)						
Source of variation	Df	MSS	F-value	S.Ed.	CD 5%	CD 1%
Treatments	62	59.087971	949.2805	--	--	--
Breeds	2	100.693329	1617.6932**	0.0314	0.0616	0.810
Days	20	144.527802	2321.9180**	0.0832	0.1630	0.2142
Interaction	40	14.287784	229.5410**	0.1440	0.2823	0.3711
Error	315	0.062245	--	--	--	--
Total (SS)	377	3683.061279	--	--	--	--
Calcium (mg/dL)						
Treatments	62	177.834351	289.8767	--	--	--
Breeds	2	224.610992	366.1244**	0.0987	0.1934	0.2542
Days	20	465.070892	758.0831**	0.2611	0.5117	0.6726
Interaction	40	31.877232	51.9611**	0.4522	0.8863	1.1649
Error	315	0.613483	--	--	--	--
Total (SS)	377	11218.976563	--	--	--	--
Phosphorus (mg/dL)						
Treatments	62	82.408333	1170.9969	--	--	--
Breeds	2	60.231430	855.8701**	0.0334	0.0655	0.0861
Days	20	229.147629	3256.1172**	0.0884	0.1733	0.2278
Interaction	40	10.147523	144.1932**	0.1532	0.3002	0.3945
Error	315	0.070375	--	--	--	--
Total (SS)	377	5131.484375	--	--	--	--

\*\* Significant ( $P < 0.01$ )

*Calcium.* The serum calcium levels (mg/dL) of Sahiwal heifers, cows and Jersey × Sahiwal cows ranged from  $10.59 \pm 0.29$  to  $27.17 \pm 0.29$ ,  $10.84 \pm 0.27$  to  $26.61 \pm 0.46$  and  $10.45 \pm 0.33$  to  $36.76 \pm 0.71$  respectively during their adaptability. In Sahiwal heifers and cows higher serum calcium levels were recorded during the first three days, which later declined to the normal range of the species, whereas in Jersey × Sahiwal cows higher levels were observed during the first six days.

A non-significant difference was observed in serum calcium levels between Sahiwal heifers and cows, whereas a highly significant ( $P<0.01$ ) variation was recorded with Jersey × Sahiwal crossbred cows.

**Phosphorus.** The serum phosphorus levels (mg/dL) of Sahiwal heifers, cows and Jersey × Sahiwal cows ranged from  $5.85 \pm 0.05$  to  $18.91 \pm 0.21$ ,  $5.94 \pm 0.08$  to  $18.87 \pm 0.12$  and  $5.88 \pm 0.10$  to  $20.80 \pm 0.13$  respectively during their adaptability. The phosphorus levels of the Sahiwal heifers and cows were higher during the first three days and later declined to the normal range of the species, whereas in Jersey × Sahiwal cows higher phosphorus levels were observed during the first six days.

A non-significant difference was observed in serum phosphorus levels of Sahiwal heifers and cows, whereas a highly significant ( $P<0.01$ ) variation was recorded with Jersey × Sahiwal crossbred cows (Table 3).

Table 4. Correlation coefficient of haematocrit, glucose and urea levels in pure and crossbred animals in relation to meteorological data during adaptability (n = 6)

Meteorological parameter	Haematocrit (PCV)			Glucose			Urea		
	Sahiwal heifers	Sahiwal cows	J × S cows	Sahiwal heifers	Sahiwal cows	J × S cows	Sahiwal heifers	Sahiwal cows	J × S cows
Temperature Humidity Index	0.5698**	0.5902**	0.5004*	0.5396*	0.5761**	0.5275*	0.5535**	0.5939**	0.5161*
Relative humidity (%)	0.3084	0.2494	0.1481	0.1962	0.1936	0.2171	0.2395	0.2344	0.2243
Maximum temperature (°C)	0.3750	0.4226	0.5386*	0.4379*	0.4860*	0.5018*	0.4398*	0.4736*	0.4729*
Minimum temperature (°C)	0.0630	0.0618	-0.0434	0.0080	0.0214	0.0031	-0.0026	0.0222	-0.0384
Average temperature (°C)	0.5030*	0.5390*	0.5141*	0.5305*	0.5966**	0.5004*	0.5557**	0.5701**	0.5185*
Evaporation (mm)	0.2764	0.2713	0.4061	0.3651	0.3146	0.4641*	0.3098	0.3502	0.3789
Wind velocity (kmph)	-0.1325	-0.1313	-0.2061	-0.1689	-0.1839	-0.2308	-0.1751	-0.1964	-0.1671
Sunshine (hours)	0.3333	0.3652	0.6306**	0.4954*	0.5011*	0.5620**	0.4908*	0.5010*	0.5980**

\* Significant  $P<0.05$  ( $r \geq 0.433$ ); \*\* Significant  $P<0.01$  ( $r \geq 0.549$ )

The correlation coefficients of haematocrit, glucose and urea in Sahiwal heifers, cows and Jersey × Sahiwal crossbred cows are presented in Table 4. The Temperature Humidity Index × correlated highly significantly ( $P<0.01$ ) with haematocrit values in Sahiwal heifers and Sahiwal cows whereas correlation was observed at  $P<0.05$  in Jersey × Sahiwal crossbred cows. The relative humidity and evaporation were not significantly



correlated with haematocrit values among Sahiwal heifers, Sahiwal cows and Jersey × Sahiwal crossbred cows. The average temperature was significantly ( $P < 0.05$ ) correlated with haematocrit values among all the three groups of experimental animals. A negative correlation was observed between wind velocity and haematocrits of three groups of experimental animals. Sunshine was highly significantly ( $P < 0.01$ ) correlated with haematocrit values in Jersey × Sahiwal crossbred cows.

Table 5. Correlation coefficient of creatinine, calcium and phosphorus levels in pure and crossbred animals in relation to meteorological data during adaptability ( $n = 6$ )

Meteorological parameter	Creatinine			Calcium			Phosphorus		
	Sahiwal heifers	Sahiwal cows	J × S cows	Sahiwal heifers	Sahiwal cows	J × S cows	Sahiwal heifers	Sahiwal cows	J × S cows
Temperature Humidity Index	0.4872*	0.5042*	0.5981**	0.4940*	0.4784*	0.5769**	0.4866*	0.4885*	0.5898**
Relative humidity (%)	0.2864	0.2972	0.2440	0.2880	0.2755	0.2486	0.2832	0.2917	0.2479
Maximum temperature (°C)	0.3300	0.3402	0.5018*	0.3250	0.3454	0.4891*	0.3251	0.3330	0.5050*
Minimum temperature (°C)	-0.0129	-0.0111	0.0336	-0.0065	-0.0280	0.0067	-0.0090	-0.0241	0.0219
Average temperature (°C)	0.4322	0.4358*	0.5331*	0.4424*	0.4414*	0.5180*	0.4312	0.4273	0.5346*
Evaporation (mm)	0.2238	0.2401	0.3470	0.2382	0.2455	0.3344	0.2260	0.2256	0.3600
Wind velocity (kmph)	-0.1071	-0.1213	-0.1835	-0.1373	-0.1214	-0.1735	-0.1161	-0.1111	-0.1826
Sunshine (hours)	0.3533	0.3595	0.4997*	0.3596	0.3826	0.4983*	0.3496	0.3598	0.5095*

\* Significant  $P < 0.05$  ( $r \geq 0.433$ ); \*\* Significant  $P < 0.01$  ( $r \geq 0.549$ )

The Temperature Humidity Index was highly significantly ( $P < 0.01$ ) correlated with glucose in Sahiwal cows, whereas a significant ( $P < 0.05$ ) correlation was observed in Sahiwal heifers and Jersey × Sahiwal crossbred cows. The relative humidity was not significantly correlated with serum glucose in all experimental animals. The average temperature was highly significantly ( $P < 0.01$ ) correlated with glucose in Sahiwal cows, whereas a significant ( $P < 0.05$ ) correlation was observed in Sahiwal heifers and Jersey × Sahiwal crossbred cows, while evaporation was significantly ( $P < 0.05$ ) correlated with glucose in Jersey × Sahiwal crossbred cows. A negative correlation was observed between wind velocity and glucose in three groups of experimental animals. Sunshine was significantly ( $P < 0.05$ ) correlated with glucose in Sahiwal heifers and Sahiwal cows, whereas a highly significant ( $P < 0.01$ ) correlation was found in Jersey × Sahiwal crossbred cows (Table 4).

The correlation coefficient of the Temperature Humidity Index was highly significant ( $P < 0.01$ ) with serum urea in Sahiwal heifers and cows, whereas a significant ( $P < 0.05$ ) correlation was observed in Jersey × Sahiwal crossbred cows. The relative humidity and evaporation were not significantly correlated with serum urea in Sahiwal heifers, Sahiwal cows and Jersey × Sahiwal crossbred cows. The correlation coefficient of average temperature was highly significant ( $P < 0.01$ ) with serum urea in Sahiwal heifers and cows, whereas a significant ( $P < 0.05$ ) correlation was observed in Jersey × Sahiwal crossbred cows. A negative correlation was observed between wind velocity and serum urea of all three groups of experimental animals. Sunshine was significantly ( $P < 0.05$ ) correlated with serum urea in Sahiwal heifers and cows and a highly significant ( $P < 0.01$ ) correlation was observed in Jersey × Sahiwal crossbred cows (Table 4).

The correlation coefficients of creatinine, calcium and phosphorus in Sahiwal heifers, Sahiwal cows and Jersey × Sahiwal crossbred cows are presented in Table 5. The Temperature Humidity Index was significantly ( $P < 0.05$ ) correlated with serum creatinine in Sahiwal heifers and cows and a highly significant ( $P < 0.01$ ) correlation was observed in Jersey × Sahiwal crossbred cows. The relative humidity and evaporation were not significantly correlated with the serum creatinine of Sahiwal heifers, Sahiwal cows and Jersey × Sahiwal crossbred cows. The average temperature was significantly ( $P < 0.05$ ) correlated with creatinine in Sahiwal cows and Jersey × Sahiwal crossbred cows. A negative correlation was observed between wind velocity and creatinine in all three groups of experimental animals. Sunshine was significantly ( $P < 0.05$ ) correlated with serum creatinine in Jersey × Sahiwal crossbred cows.

The Temperature Humidity Index was significantly ( $P < 0.05$ ) correlated with serum calcium in Sahiwal heifers and cows and a highly significant ( $P < 0.01$ ) correlation was observed in Jersey × Sahiwal crossbred cows. The relative humidity and evaporation were not significantly correlated with serum calcium of Sahiwal heifers, Sahiwal cows and Jersey × Sahiwal crossbred cows. The average temperature was significantly ( $P < 0.05$ ) correlated with serum calcium in all three experimental groups. A negative correlation was observed between wind velocity and serum calcium in all three groups of experimental animals. Sunshine was significantly ( $P < 0.05$ ) correlated with serum calcium in Jersey × Sahiwal crossbred cows (Table 5).

The Temperature Humidity Index was significantly ( $P < 0.05$ ) correlated with serum phosphorus in Sahiwal heifers and cows and a highly significant ( $P < 0.01$ ) correlation was observed in Jersey × Sahiwal crossbred cows. The relative humidity and evaporation were not significantly correlated with serum phosphorus in Sahiwal heifers, Sahiwal cows and Jersey × Sahiwal crossbred cows. The average temperature was significantly ( $P < 0.05$ ) correlated with serum phosphorus levels in Jersey × Sahiwal crossbred cows. A negative correlation was observed between wind velocity and serum phosphorus in all

three groups of experimental animals. Sunshine was significantly ( $P < 0.05$ ) correlated with serum phosphorus levels in Jersey × Sahiwal crossbred cows (Table 5).

### Discussion

*Haematocrit values (PCV).* In hot climates when animals are exposed to high ambient temperatures, haemo-concentrations will be developed due to dehydration, asphyxia or excitement, causing the release of erythrocytes concentrated in the spleen which can result in abnormally higher PCV levels (REECE, 2005).

The haematocrit values (L/L) of Sahiwal heifers and Sahiwal cows, which were higher during the first three days of the present study, might be due to the difference in the ambient temperature they were exposed to during the transit period and the new environment. The present findings are in agreement with the reports of SINGH and SINGH (2005) in Sahiwal heifers, SINGH and UPADHYAY (1997) and LEE et al. (1978) who reported breed, nutritional and species differences in haematocrit levels. In the case of Jersey × Sahiwal cows, the PCV values were higher for a longer period, which indicated that the crossbred cows have less heat tolerant capacity, and hence higher PCV were observed for longer periods than in the Sahiwal breed. Similar results were reported by SIVARAMAN et al. (2003) in Jersey crossbred cows, SINGH and SINGH (2005) in Karan Fries heifers, NARAYAN et al. (2007) in Frieswal cows and PRAVA and DIXIT (2008) in Frieswal cows. The significant ( $P < 0.01$ ) variation of PCV values between Sahiwal cows and Jersey × Sahiwal cows might be due to the heat induced reduction in the animals' metabolic rate (NOUTY et al., 1986).

During thermal stress, the animals suffer from dehydration, and as a result the extra cellular fluid volume will be reduced, causing haemoconcentration of the blood. Hence an ample supply of clean drinking water and administration of electrolytes would rectify the haemoconcentration, thus alleviating the heat stress of the animals.

*Glucose.* The blood glucose levels of the Sahiwal heifers and Sahiwal cows were higher during the first three days of adaptability, which indicated that the increased energy demand associated with increased respiration rate, along with a possible decrease in feed intake, might have caused some mobilization of body fat reserves to increase the plasma glucose levels, which is in agreement with the findings of SRIKANDAKUMAR and JOHNSON (2004) in Australian Milking Zebu (AMZ) cows. The rise in glucose levels might also be attributed to compensatory metabolic stress due to changing temperature and humidity, and energy loss, also reported by KULKARNI et al. (2010) in Deccani sheep. SINGH and SINGH (2005) reported similar results in Sahiwal heifers.

In the case of Jersey × Sahiwal cows, the blood glucose levels were higher for a period of six days, which might be attributed to the breed difference. SINGH and UPADHYAY (1997) reported breed differences in blood glucose levels. Further, the crossbred cows

have higher energy demand, which results in higher glucose levels than those of the Sahiwal breed. However, the blood glucose levels reported by NOUTY et al. (1986) in Holstein Friesian cows, by NATH (2006) in Jersey crossbred calves and GADARIYA et al. (2008) in bullocks are in contrast to the present findings. SIVARAMAN et al. (2002A) also reported lower glucose levels in Jersey crossbred cows, which might be due to the stress of lactation and simultaneous pregnancy, and the fact that the cows were not getting sufficient energy through diet would have reflected badly in the reduction in blood glucose in lactating cows. The significant ( $P < 0.01$ ) differences in the glucose levels of Sahiwal heifers, Sahiwal cows and Jersey × Sahiwal cows might be due to the breed differences (GUPTA et al., 1992; SINGH and UPADHYAY, 1996) and more feed intake (GANGWAR, 1985) by the animals.

To keep the cows at positive energy levels during pregnancy and lactation, they can be administered glucocorticoids for glucose induction.

*Urea.* Exposure of cows to moderate heat stress caused higher utilization of aminoacids as an energy source, with increased urea levels or mobilization of protein from muscle mass (FEKRY et al., 1989)

In the present investigation, the mean blood urea levels of Sahiwal heifers and Sahiwal cows were higher in the first three days, which might be due to the differences in protein metabolism or renal excretion of BUN in the animals, as BUN is the main end product of protein metabolism. The present findings are in agreement with those reported by KULKARNI et al. (2010) in Deccani sheep.

The blood urea levels of Jersey × Sahiwal cows were higher for the first six days, which is in conformity with the values reported by KULKARNI and TALVELKAR (1993), NATH (2006) and SIVARAMAN et al. (2002B) in different crossbreds. However, SRIKANDAKUMAR and JOHNSON (2004) reported lower BUN levels in Jersey and AMZ cattle in hot environments. The significant ( $P < 0.01$ ) variations in BUN levels in Sahiwal heifers, Sahiwal cows and Jersey × Sahiwal cows might be attributed to change of forage / feed to the animals and mainly environmental conditions. The higher BUN levels recorded in the present study might be due to increased utilization of aminoacids through mobilization of protein from muscles during thermal stress.

*Creatinine.* In hot environments, thermal stress is known to cause peripheral vasodilatation, to allow loss of body heat through sweating, and it can therefore reduce the blood flow to the internal organs. In addition, dehydration can also result in reduced blood flow to the kidneys. As a result of heat stress, the kidneys are unable to perform their normal function. The rate of excretion of creatinine is influenced by the glomerular filtration rate and creatinine is eliminated more easily than urea (GUYTON and HALL, 1996). The same was reflected in the elevated serum creatinine levels of the Sahiwal heifers and Sahiwal cows for the first three days. These results are in agreement with

the findings of SRIKANDAKUMAR and JOHNSON (2004), who reported that in Jersey and AMZ cows, the serum creatinine levels were higher for a period of six days, which is also marginally higher than that observed by NATH (2006) in Jersey crossbred calves, KULKARNI et al. (2010) and KULKARNI and TALVELKAR (1993) in Jersey crossbred cows, GADARIYA et al. (2008) and UPADHYAY and MADAN (1985) in bullocks. The significant ( $P<0.01$ ) variations in serum creatinine of Jersey × Sahiwal cows when compared to Sahiwal cows might be attributed to the lower heat tolerant capacity of the crossbred cows resulting in slower elimination of serum creatinine from the body.

*Calcium.* The serum calcium level is controlled by the parathyroid hormone, which acts on bones and kidneys to keep calcium levels constant. The parathyroid gland monitors the blood calcium concentrations in the carotid artery and secretes the parathyroid hormone, which immediately increases the renal calcium reabsorption mechanism, resulting in decreased urinary calcium loss (REECE, 2005). This fact was amply reflected in the elevated serum calcium levels in the Sahiwal heifers and Sahiwal cows observed in the present study during the first three days. The study results are in agreement with those reported by HAQUE and VERMA (1990) in Sahiwal cows. The higher calcium levels in the present study might be due to excessive secretion of parathyroid hormone in a hot environment.

In Jersey × Sahiwal crossbred cows, the significantly ( $P<0.01$ ) higher serum calcium levels observed for the period of six days are in consonance with those values reported by PRAVA and DIXIT (2006) in Frieswal pregnant and dry cows, SIVARAMAN et al. (2002B) in Jersey crossbred cows and AGGARWAL et al. (2008) in Karan Fries cows. However, lower serum calcium levels were reported by NATH (2006) in Jersey crossbred cows and RANDHAWA et al. (2006) in Frieswal cows.

Although a non-significant difference was observed in serum calcium levels between Sahiwal heifers and Sahiwal cows, the significant ( $P<0.01$ ) variation of the same constituent observed in Jersey × Sahiwal crossbred cows when compared to the native Sahiwal purebred might be attributed to the lower heat tolerant capacity of the crossbred cows in hot environmental conditions.

*Phosphorous.* Phosphorous is required for synthesis of the proteins and enzymes of the body, and plays an important role in the intermediary metabolism of carbohydrates and creatinine in reactions that occur in muscle contractions (SASTRY and RAMA RAO, 2009).

The higher phosphorous levels in Sahiwal heifers and Sahiwal cows for the first three days might be due to the differences in metabolic activities of carbohydrates during hot weather conditions. The serum phosphorous values of Jersey × Sahiwal cows were higher than the Sahiwal cows during the first six days, indicative of body mechanisms to release more phosphorous. These results are in agreement with the reports of SIVARAMAN et

al. (2002B) in Jersey crossbred cows, KULKARNI and TALVELKAR (1993) in different crossbred cows, PRAVA and DIXIT (2006) in Frieswal cows and NATH (2006) in Jersey crossbred cows. However, lower values were reported by RANDHAWA et al. (2006) in Frieswal cows.

Although a non-significant difference was observed in serum phosphorous levels between Sahiwal heifers and Sahiwal cows, a significant ( $P < 0.01$ ) variation of the same constituent in Jersey × Sahiwal cows was recorded. This might be due to heat stress leading to muscular contractions, resulting in a disturbance in carbohydrate metabolism and higher phosphorous levels in the serum.

### Conclusions

The haematocrit, glucose, urea, creatinine, calcium, phosphorous levels of the Sahiwal cows were significantly ( $P < 0.01$ ) higher during the first three days, and later declined to the normal range of the species. In the case of Jersey × Sahiwal crossbred cows, higher levels of haematocrit and the above serum constituents were observed for a period of six days, which later declined to reach the normal range of the species in tropical environments. During thermal stress, animals suffer from dehydration, and as a result the extra cellular fluid volume will be reduced, causing haemo-concentration of the blood, increased energy demand associated with elevated respiration rate, along with a possible decrease in feed intake, which might have caused some mobilization of body fat reserves to increase the plasma glucose levels. Tropical environmental stress also caused increased utilization of aminoacids through mobilization of protein from muscles, and slower elimination of creatinine. Hot environments lead to excessive secretion of the parathyroid hormone, resulting in higher calcium levels and muscular contractions (disturbance in carbohydrate metabolism), resulting from higher phosphorus levels in the serum.

Hence, it is suggested that an ample supply of clean drinking water, administration of electrolytes and providing protein rich diets to the animals, along with good quality forage would rectify the haemo-concentrations, thus alleviating the heat stress of the animals.

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**SREEDHAR, S., K. S. RAO, J. SURESH, P. R. S. MOORTHY, V. P. REDDY:**  
**Promjene hematokrita i biokemijskog profila u serumu sahival i križanaca sahival ×**  
**džersez goveda u tropskom okolišu. Vet. arhiv 83, 171-187, 2013.**

**SAŽETAK**

U radu su istraženi biokemijski pokazatelji u čistokrvnih sahival i križanih sahival × džersez goveda uzgajanih u tropskim uvjetima. Po šest životinja odabrano je iz skupina sahival junica, sahival krava i krava križanaca sahival × džersez. U istraženih životinja utvrđeni su biokemijski pokazatelji tijekom razdoblja od 21 dan. Vrijednosti hematokrita (%) kod sahival junica kretale su se u granicama od  $29,17 \pm 1,22$  do  $68,00 \pm 1,06$ , kod sahival krava od  $31,00 \pm 1,46$  do  $67,00 \pm 1,06$ , a kod krava križanaca sahival × džersez od  $31,17 \pm 1,17$  do  $75,83 \pm 0,59$ . Razlike u vrijednostima hematokrita između sahival junica i krava nisu bile statistički značajne, dok su razlike u odnosu krave - križanke bile statistički značajne ( $P < 0,01$ ). Razine glukoze, ureje i kreatinina u serumu (mg/dL) kretale su se kod sahival junica u granicama od  $61,90 \pm 1,34$  do  $97,32 \pm 0,63$ ; od  $58,61 \pm 1,20$  do  $96,90 \pm 0,65$ ; od  $59,26 \pm 0,58$  do  $113,33 \pm 0,71$ , kod sahival krava od  $11,72 \pm 0,94$  do  $47,21 \pm 0,64$ ; od  $11,70 \pm 0,65$  do  $45,44 \pm 0,42$ ; od  $14,00 \pm 0,58$  do  $63,99 \pm 0,41$  te kod krava križanki od  $1,25 \pm 0,07$  do  $9,81 \pm 0,13$ ; od  $1,29 \pm 0,09$  do  $9,90 \pm 0,17$  i od  $1,43 \pm 0,10$  do  $16,18 \pm 0,15$ . Prosječne vrijednosti glukoze u serumu bile su statistički značajno ( $P < 0,01$ ) različite između svih istraživanih skupina tijekom razdoblja prilagodbe. Razine kalcija (mg/dL) u serumu junica kretale su se od  $10,59 \pm 0,29$  do  $27,17 \pm 0,29$ , u serumu krava od  $10,84 \pm 0,27$  do  $26,61 \pm 0,46$  te u serumu križanki od  $10,45 \pm 0,33$  do  $36,76 \pm 0,71$ . Razine fosfora (mg/dL) u serumu junica bile su od  $5,85 \pm 0,05$  do  $18,91 \pm 0,21$ , u serumu krava od  $5,94 \pm 0,08$  do  $18,87 \pm 0,12$  te u serumu križanki od  $5,88 \pm 0,10$  do  $20,80 \pm 0,13$ . Razlike u razinama kalcija i fosfora između sahival junica i krava nisu bile statistički značajne dok su statistički značajne ( $P < 0,01$ ) varijacije utvrđene kod sahival × džersez križanki u odnosu na prilagodbu. Provedenim istraživanjem može se zaključiti da su razine hematokrita, glukoze, ureje, kreatinina, kalcija i fosfora kod sahival krava bile statistički značajno ( $P < 0,01$ ) povišene tijekom prva tri dana istraživanog razdoblja, a nakon toga su se snizile u granice normalne za vrstu. U slučaju krava križanki sahival × džersez, više razine hematokrita i drugih serumskih pokazatelja utvrđene su tijekom razdoblja od šest dana nakon čega su snižene do graničnih vrijednosti normalnih za vrstu uzgajanu u tropskom okolišu.

**Ključne riječi:** biokemijski pokazatelji, sahival govedo, križanci sahival i džersez

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