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*Original Article*

# Hematological Analysis of Three Breeds of Cows

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**Abstract**

Three breeds of cows namely, non descriptive (ND), Red Sindhi (RS) and cross breed Jersey (CBJ) cow, and each having three different age groups (2 years, 6 years and 10 years) were used in this study. Since the reports on the hematological profile with respect to these breeds and age are inadequate, the present study is undertaken. Among the three breeds, the highest (14.36±0.02g/dl) and the lowest (8.51±0.04g/dl) mean hemoglobin concentration were recorded in 2 years CBJ and 10 years ND cow respectively. The highest average total erythrocytes count (11.01±0.06 x$10^6$) and PCV (51.16±0.60%) were recorded in 6 years ND and 2 years CBJ cow respectively while the lowest value of total erythrocyte count (4.89±0.13 x $10^6$) and PCV (26.56±0.21%) were recorded in 2 years and 10 years ND cow respectively. The highest average MCH (22.61±0.62pg) and MCV (71.94±2.11fl) were observed in 2 years ND whereas the lowest average MCH (10.77±0.04pg) and MCV (34.08±0.04fl) were noted in 6 years ND cow. The highest MCHC (32.88±0.22%) and the lowest (28.02±0.33%) were recorded in 2 years RS and 2 years CBJ cow respectively. The highest and the lowest total leukocyte count were recorded in 2 years ND and 6 years RS cow respectively. The significant difference at $p<0.05$ and $p<0.01$ was found among the different age groups of breeds for all the hematological parameters and no significant difference was found for eosinophil and basophil count. The difference may be due to differences in age, breed and physiological status.

**Keywords:** ND Cow; RS Cow; CBJ Cow.

## Introduction

The hematological value during different physiological situations is essential for the diagnosis of various pathological and metabolic disorders, which can adversely affect the productive and reproductive performance of cows, leading to heavy economic loss [1]. Physiological equilibrium is maintained mainly by the blood in the body [2] but this equilibrium is altered in various physiological conditions changing the homeostasis of animals. In veterinary medicine, hematological examinations present an effective tool in monitoring the health and nutritional status of animal [3]. Age [4-7], sex [8], breed [4, 9], exercise [4, 10], pregnancy and lactation [11-13] and emotional states] [4] are variables to be considered when establishing reference values in domestic animals. Physiological variables such as recent activity and stress have an impact on hematological value in cattle. Despite the range, sensitivity and technology used, cattle hematology reference intervals are uniformly broad [14]. A complete blood count is a good indicator of general health, as stress and seasonal illnesses can modify hematological parameters, especially with regard to erythrocyte and lymphocyte count [15]. Seasonal parasite burdens may also alter the complete blood count (CBC) [14]. A complete blood count is undisrupted, the most important diagnostic method available to veterinarians, along with proper anamnesis and a physical examination of the animal [15]. Seasonal and environmental changes may influence the value of hematology hematology [16]. Numerous hematological and biochemical changes are associated with liver damage caused by liver flukes [17]. Aging results in WBC changes. As bovine adults age, the concentration of neutrophils and lymphocytes decreases but lymphocytes continue to be the predominant cell type [14]. Ruminants hemoglobin are of particular interest because of the large amount of polymorphism that occurs between

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species, breeds and even within the individual as it develops from embryo to adult [14]. The packed cell volume (PCV) is one of the most valuable techniques for determination of the percentage of cellular component of blood in the clinical laboratory [16]. Mean corpuscular volume is more valuable than blood film examination in assessing the true size of erythrocytes [18]. Basically an experienced pathologist performs bright-field microscopy in order to characterize the cells – red blood cells, white blood cells and platelets. However, differential counting of WBC is one of the major pathological issues in diagnosing of many health hazards. [19]. Reports on the hematological profile with respect to breed (non descriptive (ND), Red Sindhi (RS) and cross breed Jersey (CBJ)) and age, (2 years, 6 years and 10 years) are inadequate, for which the present study is designed.

## Materials and Methods

*Hematological method*

After disinfecting of the sampling area, blood samples were taken from the jugular vein [4, 20] of each individual cow and blood smears were immediately performed. After drying the smears by waving the air [4, 18] they were treated with methanol (Qualigens scientific India Pvt. Ltd., Mumbai, Maharashtra, India) for 1-5 minutes [20]. Since collection of blood directly into a vacuum tube is preferred to collection of blood by syringe and transfer to vacuum tube which reduces platelet clumping and clot formation in samples for CBC determination [21] dry and sterilized needle (Dispo Van Single Use Needle, Hindustan Syringes & Medical Devices Ltd., Faridabad, India) and dry syringe (Dispo Van Single Use Syringe, Hindustan Syringes & Medical Devices Ltd., Faridabad, India) was used for collection of blood [4]. Since EDTA is an excellent anticoagulant [4, 21], the needle of syringe was inserted through the purple cap of EDTA vial ($K_3$ EDTA, 2ml * 13 75mm, Mfg By: HXS Tech Co., Ltd.PRC. For: Peerless Biotech Pvt. Ltd., Chennai, Tamilnadu, India). Estimation of hemoglobin was done by Sahli's acid hematin method [22] with Sahli's haemometer (HiMedia GW 191-1NO, Plane haemometer (Square Type), HiMedia Laboratories Pvt. Ltd., Mumbai, Maharashtra, India). PCV was done by centrifugation (REMI CENTRIFUGE, Catalogue No.C852 7/94 and Serial NO. GCLC-1632, REMI MOTORS, Bombay, Maharashtra, India) of blood at 3,000 rpm for 15 minutes [23].

Total erythrocyte count (TEC) and total leukocyte count (TLC) were done by using the conventional method [20] by using Neubauer's counting chamber. Erythrocyte indices like, MCH, MCV and MCHC were studied according to the methods described by earlier worker [4]. Differential leukocyte (DLC) [4] was assessed by staining the smeared slide (BLUE STAR), PIC 2, Polar Industrial Corporation, Mumbai, India) with Giemsa stain prepared from Giemsa powder Qualigens CAS NO.51811-82-6 Product NO. 39382, scientific India Pvt. Ltd., Mumbai, Maharashtra, India] following the standard hematological procedure [24] under 40X objective of light microscope (LABOSCOPE MICROSCOPES Research microscope M.No. BD-08 B, S. No. 21320 Mfd. by B.D. INSTRUMENTATION, Ambala Cantt, India).

*Statistical analyses*

Mean ±SE were calculated for each parameter by using Microsoft Office Excel 2007. For comparison of means statistical analyses were done by Paleontological statistics (PAST) version 2.17 [Natural History Museum, University of Oslo] for One-Way Analysis of variance (ANOVA) followed by Turkey's pair wise comparison tests. Differences were classified as significant at $P<0.05$ and highly significant at $P<0.01$.

## Results

The value of erythrocyte parameters with respect to age and different breeds of cows are illustrated (Table 1) and the values of leukocyte parameters with respect to age and different breeds of cows are illustrated (Table 2). Among the three breeds the highest and the lowest mean hemoglobin concentrations were recorded in 2 years CB Jersey and 10 years ND cow respectively. The highest average total erythrocytes count and PCV were recorded in 6 years ND and 2 years CBJ cow respectively while the lowest values were recorded in 2 years and 10 years ND cow respectively. The highest average MCH and MCV were observed in 2 years ND whereas the lowest were noted in 6 years ND cow. The highest and the lowest MCHC were recorded in 2 years Red Sindhi and 2 years CBJ cow respectively. Different hematological parameters of ND cow, RS cow and CBJ cow are recorded (Fig.1, Fig.2 and Fig.3). Average percentages of leukocytes in ND cow (Fig.4), RS cow (Fig.5) and CBJ cow (Fig.6) is shown.

As shown (Table 1) for concentration of hemoglobin (g/dl), 2 years CBJ cow reflect highly

**Table 1:** Erythrocyte parameters with respect to age and different breeds of cows

| Erythrocyte parameters/Age-groups and breeds | | Hb (g/dl) | TEC (x10$^6$ per mm$^3$) | PCV ( %) | MCV (fl) | MCH (pg) | MCHC (%) |
|---|---|---|---|---|---|---|---|
| 2 years | ND (3) | 11.04±0.07$^{a}$ | 4.89±0.13$^{a}$ | 35.13±0.47$^{a}$ | 71.94±2.11$^{a}$ | 22.61±0.62$^{a}$ | 31.43±0.21$^{a}$ |
| | RS (3) | 10.35±0.02$^{a,b,c,d}$ | 7.96±0.05$^{a,d}$ | 31.50±0.28$^{a,b,c,d}$ | 39.57±0.09$^{a,b,c,d}$ | 13.00±0.06$^{a,b,c,d}$ | 32.88±0.22$^{d,f}$ |
| | CBJ (3) | 14.36±0.02$^{a,b,c,d,e,g}$ | 7.74±0.029$^{a,c,e,f,g}$ | 51.16±0.60$^{a,b,c,e,f,g}$ | 66.23±2.17$^{a,b,c,e,g}$ | 18.59±0.70$^{a,b,c,d,e,f}$ | 28.02±0.33$^{a,b,c,d,f,g}$ |
| 6 years | ND (3) | 11.86±0.01$^{a,b}$ | 11.01±0.06$^{a,b}$ | 37.53±0.24$^{a,b}$ | 34.08±0.04$^{a,b}$ | 10.77±0.04$^{a,b}$ | 31.60±0.15$^{b}$ |
| | RS (3) | 13.31±0.06$^{a,b,c,d,e}$ | 6.31±0.01$^{a,b,d}$ | 45.34±0.08$^{a,b,c,d,e}$ | 71.81±0.02$^{b,c,d,e}$ | 21.08±0.05$^{b,c,d,e}$ | 29.36±0.08$^{a,b,c,d,}$ |
| | CBJ (3) | 13.31±0.05$^{a,b,c,d,g}$ | 7.40±0.03$^{a,b,c,e,f}$ | 44.50±0.76$^{a,b,c,d,g}$ | 60.33±0.98$^{a,b,c,d,e,f,g}$ | 17.96±0.16$^{a,b,c,d,e,f}$ | 29.80±0.74$^{a,b,c,d,g}$ |
| 10 years | ND (3) | 8.51±0.04$^{a,b,c}$ | 5.79±0.03$^{a,b,c}$ | 26.56±0.21$^{a,b,c}$ | 45.85±0.11$^{a,b,c}$ | 14.69±0.01$^{a,b,c}$ | 32.04±0.95$^{e}$ |
| | RS (3) | 13.86±0.06$^{a,b,c,d,e}$ | 6.78±0.04$^{a,b,c,d,e,f}$ | 46.16±0.60$^{a,b,c,d,f}$ | 68.05±0.55$^{b,c,d,f}$ | 20.44±0.11$^{a,b,c,d,f}$ | 30.04±0.28$^{c,d,f}$ |
| | CBJ (3) | 13.38±0.03$^{a,b,c,d,g}$ | 7.13±0.04$^{a,b,c,d,g}$ | 44.36±0.31$^{a,b,c,d,g}$ | 62.22±0.23$^{a,b,c,d,e,f}$ | 18.76±0.08$^{a,b,c,d,e,f}$ | 30.15±0.19$^{c,d,g}$ |
| F value | | 1662** | 221.9** | 316** | 174.1** | 148.1** | 22.14** |

[1]Mean±SE with similar superscripts in the same column differ significantly at p<0.05 and p< 0.01

[2]Significant at **p<0.01

[3]Figures in parentheses represent the number of observations in each case

F value: Fischer's value

**Table 2:** Leukocyte parameters with respect to age and different breeds of cows

| Leukocyte parameters/Age groups and breeds | | TLC (x10$^3$ per mm$^3$) | Lymphocytes (%) | Monocytes (%) | Neutrophils (%) | Eosinophils (%) | Basophils (%) |
|---|---|---|---|---|---|---|---|
| 2 years | ND(3) | 26.00±0.26$^{a}$ | 72.33±3.17 | 5.00±1.52$^{a}$ | 14.00±2.501$^{a}$ | 4.66±0.33 | 1.33±0.33 |
| | RS(3) | 11.73±0.27$^{a,b,d}$ | 80.00±6.00$^{d}$ | 3.66±0.33$^{c}$ | 8.00±4.16$^{d}$ | 1.66±1.20 | 3.00±1.15 |
| | CBJ(3) | 14.33±0.14$^{a,b,c,d,e,f,g}$ | 56.50±1.50 | 3.50±0.50$^{c}$ | 22.00±1.00$^{e}$ | 7.00±0.00 | 1.00±1.00 |
| 6 years | ND(3) | 16.68±0.23$^{a,b}$ | 74.50±14.50$^{b}$ | 3.00±1.00$^{b}$ | 16.00±11.00$^{b}$ | 4.00±1.00 | 2.50±1.50 |
| | RS(3) | 8.93±0.10$^{a,b,c,d,e}$ | 40.66±3.28$^{b,d,e}$ | 2.33±0.33$^{c}$ | 46.33±1.45$^{a,b,c,d,e}$ | 2.00±0.00 | 2.00±1.00 |
| | CBJ(3) | 10.78±0.11$^{a,b,c,d,e,f,g,h}$ | 65.00±8.62 | 2.66±1.20$^{c}$ | 17.66±3.17$^{e}$ | 10.33±4.80 | 1.00±1.00 |
| 10 years | ND(3) | 11.08±0.07$^{a,b,c}$ | 51.00±7.00 | 24.00±3.05$^{a,b,c}$ | 17.66±6.88$^{c}$ | 2.33±2.33 | 1.33±0.33 |
| | RS(3) | 15.51±0.21$^{a,b,c,,d,e,f}$ | 73.00±1.00$^{e}$ | 4.33±1.20$^{c}$ | 16.66±2.33$^{e}$ | 1.00±0.00 | 1.66±0.88 |
| | CBJ(3) | 15.71±0.04$^{a,b,c,d,e,g,h}$ | 72.00±3.00 | 1.00±1.00$^{c}$ | 11.00±0.00 | 10.50±1.50 | 0.50±0.50 |
| F value | | 764.50** | 4.67* | 23.21** | 7.02** | 2.14$^{NS}$ | 0.71$^{NS}$ |

[1] Mean±SE with similar superscripts in the same column differ significantly at p<0.05 and p< 0.01

[2]Significant at *p<0.05 and **p<0.01, NS means not significant

[3]Figures in parentheses represent the number of observations in each case

F value: Fischer's value

**Fig. 1:** Different hematological parameters of Sindhi non descriptive cow

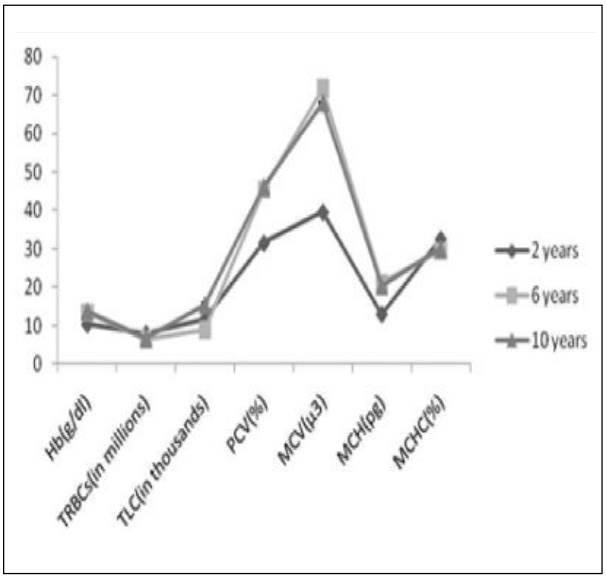



**Fig. 2:** Different hematological parameters of cow.

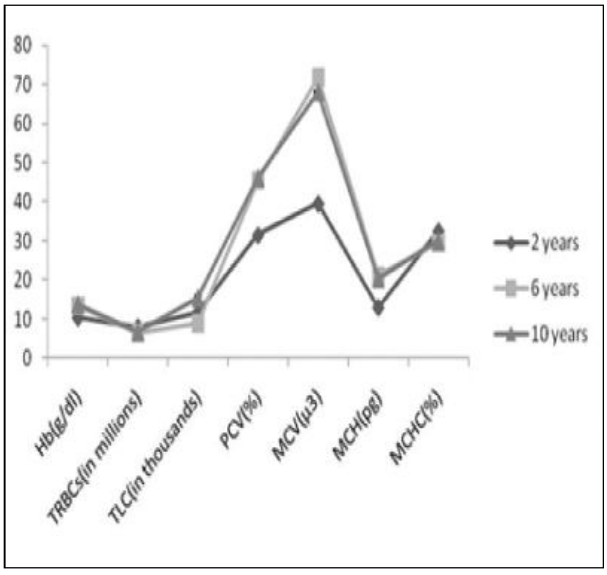


**Fig. 3:** Different hematological parameters of cross breed Jersey cow

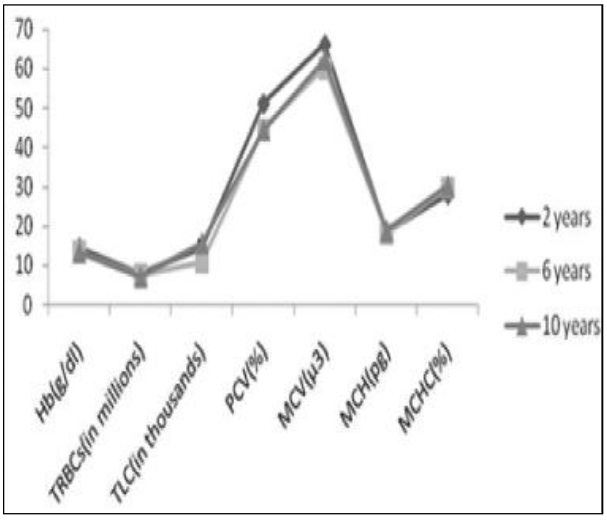



**Fig. 4:** Average percentages of leukocytes in non descriptive cow

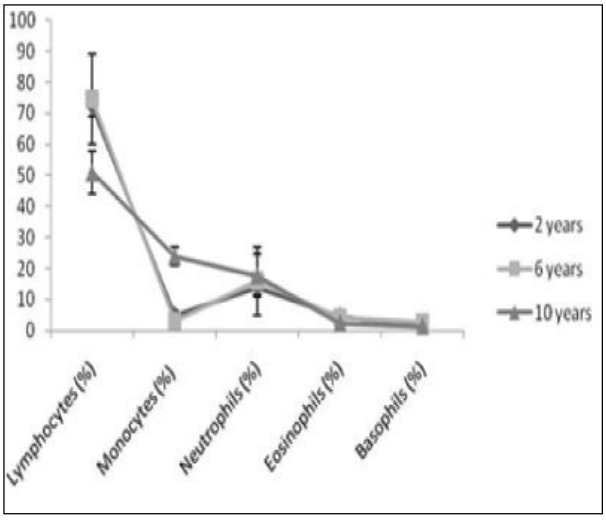



**Fig. 5:** Average percentages of leukocytes Red Sindhi cow

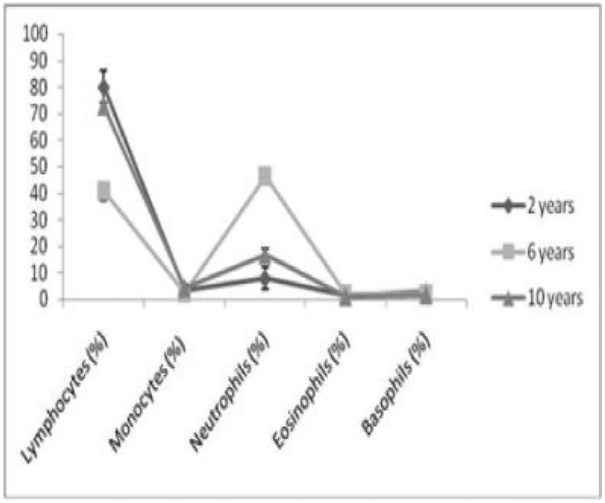
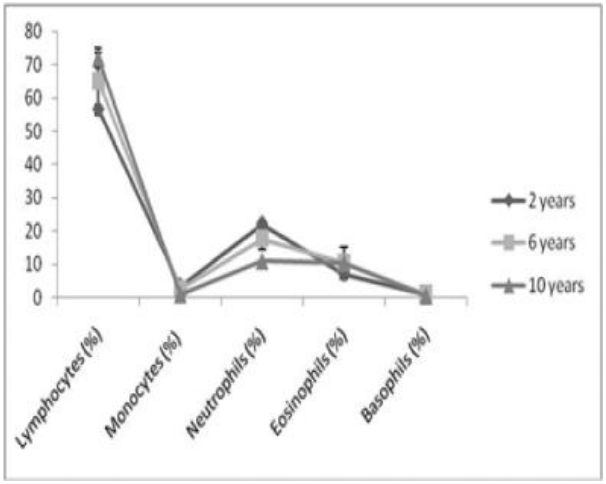



**Fig. 6:** Average percentages of leukocytes in cross breed in Jersey cow




significant difference (p=0.0001) with each age group of ND and RS cow. Ten years has highly significant difference (p = 0.0002) with each age group of ND, 2 and 10 years RS and 2 years CBJ cows.

For total RBCs count, there exists highly significant difference (p=0.0002) between 2 years and 6 years ND cow. Ten years ND cow has highly significant difference (p<0.01) with 2 years and 6 years ND cow. Two years RS has highly significant difference with 2 years and 6 years ND cow and 10 years RS cow (p=0.0002). Both 6 years and 10 years RS have highly significant difference (p=0.0002) with 2 years and 6 years ND cow. Both 2years and 10 years RS cows have highly significant difference (p<0.0005) with 10 years ND cow. Both CB Jersey 2 years and 6 years have highly significant difference (p=0.0002) with each age group of ND cow and RS cow of 6 years and 10 years. Ten years CB Jersey has highly significant difference (P=0.0002) with each age group of ND cow and RS cow with the exception to 10 years RS cow. Significant difference (p=0.03) exist between CBJ of 2 years and 10 years.

For PCV, significant differences (p=0.029) are there between 2 years and 6 years ND cow. Ten years ND cow has highly significant difference (p=0.0002) with 2 years and 6 years ND cow. There exist highly significant differences (p=0.0002) between 6 years Red Sindhi cow with all the age groups of ND cows and 2 years RS cow. Two years, 10 years RS and all age groups of CBJ cows have highly significant differences (p=0.0002) with all the age groups of ND cow. Besides that, 2 years CBJ has also significant differences (p=0.0002) with 6 years and 10 years Red Sindhi cow. Both 6 years and 10 years CBJ cows have highly significant differences with 2 years CBJ cow (p=0.0002).

For MCV, 6 years ND cow has highly significant difference with 2 years ND cow. Ten years ND has highly significant difference (p=0.0002) with both 2 years and 6 years ND cow. Two years RS has highly significant difference (P=0.0002) with 2 years ND cow. Significant difference (p=0.043) is there between 2 years RS and 6 years ND, and between 2 years RS and 10 years ND cow (p=0.015). Six years RS has highly significant differences (p=0.0002) with 6 years and 10 years ND cow and with 2 years RS cow. Ten years RS has highly significant difference (p=0.0002) with 6 years and 10 years ND cow and with 2 years RS cow. Two years CBJ has significant difference (p<0.05) with 2 years ND and 6 years RS cow. Six years CBJ shows highly significant (p=0.0002) with each age group of ND and RS cow. Two years and 6 years CBJ reflect significant difference (P=0.025). Each age group of ND and RS cow besides 10 years RS have highly significant difference (P<0.0004) with 10 years CBJ cow. Two years CB Jersey and 10 years CBJ reflect significant difference (p<0.05) between them.

For MCH, 6 years ND has highly significance difference (p=0.0002) with 2 years ND cow. Ten years ND cow has highly significant difference (p<0.0002) with both 2 years and 6 years ND cow. Six years RS reflect highly significant difference (p<0.0002) with 6 years and 10 years ND and 2 years RS cow. Ten years RS cow has highly significant difference with each age group of ND and 2 years RS cow. All the age groups of CBJ have highly significant difference with each age group of ND and 2 years and 6 years RS cow. Two years CBJ has significant difference (p<0.05) with 10 years RS cow. Six years and 10 years CBJ has highly significant difference (p<0.05) with 10 years RS cow.

For MCHC, highly significant difference (p<0.01) occur for 6 years RS cow with each age group of ND and 2 years Red Sindhi cow. For 10 years Red Sindhi cow highly significant difference (p<0.009) are there with 10 years ND and 2 years Red Sindhi cow. Ten years Red Sindhi has highly significant difference (p<0.01) with 10 years ND and 2 years Red Sindhi cow. Highly significant difference (p=0.002) exists for 2 years CB Jersey with each age group of ND and 2 years Red Sindhi cow. Two years CBJ and 10 years Red Sindhi reflect highly significant (p=0.007) between them. Highly significant difference (p<0.003) exist between 6 years CBJ and 10 years ND and between 2 years Red Sindhi and 6 years CBJ cow. Ten years CBJ shows significance difference (p<0.05) with 10 years ND cow. Highly significant differences (p<0.005) exist between 2 years and 10 years CBJ cow and between 2 years RS and 10 years CBJ cow (p<0.0005).

The highest and lowest total leukocyte counts were recorded in 2 years ND and 6 years RS cow respectively. As shown in Table II for TLC, 2 years ND has highly significant difference with 6 years ND cow. Both 10 years ND and 2 years RS cow have highly significant differences with 2 years and 6 years ND cow. Six years RS cow has highly significant difference with each age group of ND cow and 2 years RS cow. Ten years RS shows highly significant differences with each age group of ND cow and with 2 years and 6 years RS cow. Two years CBJ has highly significant difference (p<0.008) with each age group of ND and RS cow. Six years CBJ has significant difference (p<0.05) with 2 years and 6 years ND cow and highly significant difference (p<0.003) with 10 years ND and 2 years RS cow. Highly significant difference (p=0.0004) exists between 10 years CBJ and 2 years RS cow and significant difference (p=0.022) exits between 2 years and 6 years CBJ cow. Ten years CBJ cow reflect significant difference (p=0.013) with 10 years ND cow and highly significant difference (p<0.005) with 2 years RS cow and 2 years CBJ cow.

For percentage of lymphocytes, significant differences (p< 0.05) are there between 6 years ND and 6 years RS cow, between 2 years RS cow and 6 years RS cow and between 6 years RS and 10 years RS cow. For percentage of monocytes, highly significant differences (p<0.01) are there between 2 years and 10 years ND cow and between 6 years and 10 years ND cow. Ten years ND has highly significant differences (p<0.01) with all the age groups of RS and CBJ cow. Six years RS has highly significant difference (p<0.01) with all the age groups of ND and 2 years RS cow. Six years RS has highly significant difference (p<0.01) with 2 years RS and 6 years CBJ cow and significant differences are there between 6 years RS and 2 years CBJ cow. No significant difference is found for percentages of eosinophils and basophils among the breeds with respect to age groups.

## Discussion

Previous author [4] opined normal ranges for hematological value of cattle, i.e., Hb (g/dl) range from 8-15, RBCs ($x10^6/mm^3$) range from 5-10, PCV (%) range from 24-26, MCV($\mu^3$) range from 40-60, MCH (μμg) ranges from 11-17, MCHC (%) range from 30-36, WBC ($x10^3/mm^3$) range from 4-12, neutrophils range from 15-45%, lymphocytes range from 45-75%, monocytes range from 2-7%, eosinophils range from 2-20% and basophils range from 0-2%. Our findings

regarding RBCs ($x10^6/mm^3$) are in close agreement with author [4] for 2 years and 10 years ND cow and all the age groups of RS and CBJ cows. Regarding PCV (%) our findings are in close agreement with [4] for all the age groups of ND cow, 2 years and 6 years RS cow, 6 years and 10 years RS cow. Regarding Hb (g/dl) are in close agreement with each age group of three breeds of cows. In this present study, MCH of 10 years ND cow is in close accordance with [5]. The present results for MCHC are in close accordance with [4] for all the age groups of ND cow and 2 years RS cow. The present studies for WBC are in close agreement with [4] for 10 years ND, 2 years and 6 years RS and 6 years CBJ cow. Regarding percentage of monocytes, our present findings are in close agreement with 2 years and 10 years ND cow, all the age groups of RS cow and with 2 years CBJ cow. The results of present findings with regard to percentage of eosinophils are in close agreement with [4] for 2 years and 6 years ND cow, 2 years RS cow, 2 years and 10 years CBJ cow.

The present study regarding hemoglobin content of CBJ cow (Table 1) is accordance with earlier worker [25] who reported a decrease in hemoglobin content when calves grew older. The average amount of hemoglobin in the blood of normal beef and dairy cattle of various ages has been reported by various workers to vary from 10.9 to 13.2g per 100ml of blood [26-32]. The study is in close agreement with [26-32] for 2 years, 6 years and 2 years RS cow; differences are found for other breeds may be due to their body weight, breed differences, age differences, and seasonal variations. Late pregnancy and onset of lactation is a period when slight anemia exits [33]. This statement can be interpreted with 6 years ND cow which is deviated from the statement as described by earlier author [26-32]. A range of 13.2 to 13.95g/dl and a range of 13.2 to 14.35g/dl hemoglobin are found in two age groups (6 years and 10 years) RS cow and three different age groups of CBJ cow respectively in our study which may lead to hemoconcentration.

Our study for all the breeds except 6 yrs ND cow is agreement with those [25, 30, 34-37] who observed a range of 4.9 to 9.98 million red blood cells per cu mm of blood. In this study the mean for red blood counts is slightly lower than 6.55 millions, i.e., 6.31 millions in 6 years RS and slightly higher than 6.55 millions, i.e., 6.79 millions as explained by earlier author [38] for Jerseys and mean red blood counts of CBJ is closely related with Guernseys having 7.49millions /cu mm as explained by [38]. Mean TRBC observed in this study for ND cow is deviated from the other breeds of dairy cows such as Jerseys, Guernseys and Holsteins [38] indicating the differences in breed among the dairy cows.

The breed difference for PCV (%) found in this study has also been documented in different breeds of dairy cattle namely Holsteins (39.5%), Jerseys (42.3%) and Guernseys (46%) [37]. Haematocrit values or PCV (%) observed in our study except in 10 years ND cow whose average PCV (%) is slightly lower and 2 years CBJ whose average PCV (%) is slightly higher are in close agreement with those [39-40, 25] who reported that a range in average haematocrit values in dairy cattle varies from 28 to 50%. The average haematocrit values obtained in this study has also been documented in beef cattle from 31% to 48% [32] with the exception for 10 years ND and 2 years CBJ cow. The differences are found due to breed difference.

For MCV, [25] calculated that mean corpuscular volume on 233 dairy calves from birth to one year of age whose extreme values were 28 to 112 cubic microns. Our study can be interpreted with [25] that after one year of age the values were also within the range.

Previous worker [39] has reported a range of 14.2 to 18.5 micro micrograms with mean of 15.7 micro micrograms for mean corpuscular hemoglobin content of the blood of the adult cow. The present results are in accordance with the author [38] for MCH of 10 years ND and 6 years CBJ cow. Our findings regarding MCHC are in close agreement with previous worker [36] for each age group of ND cow and 2 years RS cow who observed average of 32.0 and 37.2% for mean corpuscular hemoglobin in dairy and beef cattle. The average for MCHC obtained in present study except 10 years ND and 2 years RS cow differed from the result obtained by [36] who found average of 32.0% and 37.2% for MCH for dairy and beef cattle respectively.

The range of TLC with respect to age and breed observed in this study has also been documented for different age groups of dairy calves as stated by [25] who found that number of leukocytes per cu mm of blood, in dairy calves from birth to a year of age, ranged between 4,500 and 15,000 with the majority ranging from 6,500 to 11,500 per cu mm. Earlier worker [25] has reported a decrease in the number of lymphocytes as calves grew from birth to one year of age and observed the number of monocytes, neutrophils and eosinophils to be variable from age to age while basophils were absent. Our study can be interpreted with [25] for variable number of leukocytes in different age groups of cows.

One author [36] opined normal ranges for differential leukocyte counts of cattle, i.e., neutrophils range from 1-15 which has been observed for 2 years

ND and 10 years CBJ cow in this present study, eosinophils range from 1-15, which is seen in all the breeds of cows except in 6 years CBJ cow and 10 years ND cow, basophils range from 0-1, lymphocytes range from 40-70 which has been seen in 10 years ND, 6 years RS and 2 years CBJ cow in our present study and monocytes range from 3-15, which is observed in 2 years RS and 2 years CBJ cow in our study. According to [4] more exercise causes leukocytosis which can be interpreted with increase in TLC in 2 years ND cow. MCHC is mostly normal but in certain anemia there is reduction of hemoglobin while the cell volume is normal; for example in iron deficiency MCHC is decreased [4].

Age [4-7], breed [4, 9], exercise [4, 10] and emotional states [4] influence the differential leukocyte count which can be interpreted with our study. Our study is in close agreement with [4] who stated that in cattle lymphocytes are always more in number than neutrophils. In 6 years RS cow there is more neutrophils than lymphocytes which is in accordance with [4] who opined that emotional states also influence the differential leukocyte count, i.e., besides the high leukocyte counts there is neutrophilia in fear and there is neutrophilia during exercise. This increase in the neutrophil count may be due to increased level of cortisol because of stress [41]. However, neutrophilia has also been reported during excitement, exercise, adrenaline and ACTH release [42]. Lymphocytes decrease around parturition mainly due to reduced lymphocyte proliferation [43].

According to [4] at birth TLC is high in calf, exercise causes leukocytosis and in fear high leukocyte counts are there which can be interpreted with 2 years ND cow having more TLC having one of the above causes.

The differences found for each hematological parameter were may be due to differences in age, breed and physiological status. Numerous reference values for domestic cattle have been reported and reveal few breed differences. Breed differences have been reported for beef cattle, which have higher RBC values, compared to dairy cattle breeds [14]. Care must be taken to use reference intervals that include similar environmental conditions and seasons as well as physiologic variables [14]. Reference values are influenced by age, sex, physical activity, etc. [5-8, 44-46] and in veterinary medicine the additional species, breed and management factors greatly magnify the effort required to generate reference values for each subpopulation of interest [47]. The accuracy and precision of the laboratory techniques as modified by reagents, temperature and instrumentation etc can effect reference values from a par ticular population [44, 46, 48-50] .

Discrepancies in values for various hematological parameters between our findings and previous studies may be explained by differences in sampling interval, methods used, number of cows sampled, and / or degree of metabolic disturbances as described by some authors [51]. Moreover, genetic differences between cows [52] and environmental conditions [51] of the present study might have played a role for the differences with other studies. Differences may also be due to their body weight, breed difference, age differences, and seasonal variations.

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