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Evaluation of Red Cell Distribution Width (RDW) in Anemic Goats

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ABSTRACT

Background: Red cell distribution width (RDW) measures the degree of anisocytosis in an erythrocyte population and was expressed as the coefficient of variation of the erythrocyte size distribution data. In recent studies, RDW has been evolved as a new predictive marker and as an independent risk factor in assessing the severity and progression of disease conditions. The data regarding RDW in goats was found lacking particularly in conditions like anemia.

Methods: The study was conducted at Veterinary Clinical Complex, VCRI Orathanadu. The EDTA blood samples from suspected cases were collected and analyzed by Veterinary specific automated hematology analyzer. During the study goats with hemoglobin values lesser than and or equal to 8.0 g/dl were selected to evaluate the RDW alterations in them.

Result: The Red cell distribution width was found elevated (36.94±0.29%) in anemic goats when compared to the healthy reference. The data of the Red cell distribution width in goats was recorded and statistically analysed.

Key words: Anemia, Goat, MCV, Red cell distribution width (RDW).

INTRODUCTION

Anemia in small ruminants causes severe economic losses to livestock farmers by poor weight gain, abortions and mortality in them. It was mainly caused by endoparasitic infestations with helminthic worms and ectoparasites like ticks and their associated infections. The measurement of red blood cell distribution width (RDW) could provide a newer approach to the anemia (Souza *et al.,* 2012).

Souza *et al.* (2017) reported RDW as a sensitive tool to assess erythrocyte sizes and variations and found more accurate than microscopic observations in detecting anisocytosis. It was also found more sensitive than MCV in assessing erythrocyte variations.

Extensive studies indicated Red Blood Cell Distribution width was used as a perdiction factor in various disease conditions in human medicine especially in cardiovascular disease (Patel *et al.,* 2013), iron deficiency anemia (Piriyakhuntorn *et al.,* 2018) and pulmonary hypertension (Yang *et al.,* 2019). Further, few studies in Veterinary Medicine were also reported with special reference to canines anemias (Souza *et al.,* 2017), pulmonary hypertension (Swann *et al.,* 2014) and other illnesses (Martinez *et al.,* 2019). The red blood cell distribution width (RDW) means measurement of degree of anisocytosis in the erythrocyte population and expressed as the coefficient of variation of the erythrocyte size distribution (Pastor *et al.,* 1997; Hammarsten *et al.,* 2010). The microscopic assessment of degree of anisocytosis has limitations and also found to be a time-consuming procedure which was later replaced by automated hematological analyzer providing immediate value along with estimations of all the hematological parameters.

Currently most of the veterinary institutes and private veterinary clinics were having modern automated hematological analyzers with species specific software to assess the hematology status and initiate effective therapeutic management in the ailing animals. There was limited data available on RDW in goats and was found particularly lacking in goat anemias. Hence the present study could provide the base line data for Red Blood Cell Distribution Width in goats.

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MATERIALS AND METHODS

The study was conducted at Veterinary Clinical Complex, Veterinary College and Research Institute, Orathanadu, Thanjavur, Tamil Nadu, Tamil Nadu Veterinary and Animal Sciences University, Chennai, India. Latitude and longitude of the study area 10.6286°N, 79.2531°E. Instrument: Veterinary specific automated hematology analyzer (Vet Scan HM5, Germany) and the parameters selected for analysis were Hgb, HCT, RBCs, MCV, MCH, MCHC, RDW (RDWs and RDW_C). The cases presented to the Veterinary diagnostic laboratory of Veterinary Clinical Complex, Veterinary College and Research Institute, Orathanadu, Thanjavur were selected for the study and the data was collected during the period 2015 to 2019.

Erythrocytes play an important role in the transport of oxygen during blood circulation. Alterations in RBCs volume and size would affect the organ and tissue perfusions. RDW was found more sensitive than MCV in assessing types of anemia and their prognosis (Neiger *et al.,* 2002). Basing on the data available, cases with hemoglobin values lesser than and or equal to 8.0 g/dl and PCV less than and or equal to 22% were selected for the present study.

During the study a total of 264 blood samples collected from goats were processed in automated hematology analyzer. Out of which, 194 cases were found having hemoglobin and PCV values lesser than and or equal to 8.0 g/dl and 22%, respectively.

The RDW was used to describe the amount of variation in the size of red blood cells namely anisocytosis. RDW may be further reported as either standard deviation (RDWs) or coefficient of variation (RDWc), however RDWc was commonly employed. One standard deviation of RBC volume divided by the MCV times 100 *i.e.*

$$\frac{SD}{MCV} \times 100$$

Red blood cells were found fairly uniform in size however an increase or decrease in variation *i.e.*, anisocytosis could lead to changes in RDW.

Blood samples were collected from jugular vein in 2 ml capacity K_3EDTA coated tubes and gently stirred for complete mixing of anticoagulant with blood and also just before analysis. The collected blood samples were processed in automated hematology analyzer (Vet Scan HM5, Germany) as per the instructions of manufacturer. Further the data of blood samples collected from anemic goats were compared with healthy (control) goats (n-7) maintained in the Livestock Farm Complex of Veterinary College and Research Institute, Orathanadu.

The effect of anemia between hematology indices was analyzed by t-test and expressed as Mean±Standard error (SE). Pearson's correlation coefficient was used to test associations between variables. Results were considered significant at $p<0.05$ and highly significant at $p<0.01$ levels. Ethical statement: No ethical concern/permission was required for the present study.

RESULTS AND DISCUSSION

In the present study, 194 goats were found suffering from anemia. The details of Mean, Standard error (SE) and t-test values of anemic (n-194) vs healthy goats (n-7) were presented in Table 1. On statistical analysis, Hemoglobin, Hematocrit, Mean corpuscular volume and Mean corpuscular hemoglobin were found highly significantly ($p<0.01$) decreased when compared to healthy goats.

According to Martinez *et al.* (2019) RDW was studied extensively in human patients whereas in dogs the quantitative measure of erythrocyte anisocytosis was limited. Further it augmented the diagnostic information in the anemic patients and also provided prognosis in varied disease conditions. In view of the relative scarcity of literature on RDW an effort has been made to study the variation of RDW in anemic goats.

The red blood cell distribution width (RDW) was considered as an index of the heterogeneity of circulating red blood cell size and conventionally referred to as anisocytosis and could be assessed by modern hematology analyzers (Lippi and Plebani, 2014; Salvagno *et al.,* 2015).

RDW was found elevated under conditions of erythropoietic stress like iron, Vitamin B_{12} and folate deficiencies (Lippi and Plebani, 2014). Red blood cell damage caused by oxidative stress could lead to elevated RDW and decrease in lifespan of the erythrocytes (Semba *et al.,* 2010). It could be suggested that supplementation of antioxidant nutrients may influence the RDW in anemic goats. Further an increase in RDW was also observed in regenerative anaemias because of increase in reticulocytes count rather than mature erythrocytes (Cavaliere, 2004). Zvorc *et al.* (2010) reported that RDW could be a useful indicator of the appearance of a younger population and increase in RDW occurs before the MCV exceeds the reference interval.

The details of the correlation between the variables *i.e* RDW indices (RDWs and RDWc) and Hb, HCT, MCV and RBCs in anemic goats (n=194) were presented in Table 2. The MCV was found positively correlated with RDWs and negatively correlated with RDWc. However, both RDWs and RDWc were found statically highly significant ($p<0.01$) with MCV. Hence, it may be construed that MCV strongly correlates with RDWs and RDWc. In the study, Hematocrit (HCT) was found negatively correlated with RDWs and RDWc, wherein RDWc was found statically highly significant ($p<0.01$) and RDWs significant ($p<0.05$). Similarly, Hemoglobin (Hb) was also found negatively correlated with RDWs and RDWc, wherein RDWs was found statically highly significant ($p<0.01$) and RDWc significant ($p<0.05$). In addition, RBCs was also found negatively correlated with RDWs and RDWc, wherein RDWs was found statically highly significant ($p<0.01$) and RDWc as non-significant.

Guglielmini *et al.* (2021) reported increase in RDW was significantly associated with a negative outcome in dogs with myxomatous mitral valve disease (MMVD), with or without concurrent infections, on treatment, independently from anaemia and or concomitant changes in MCV.

RBC indices in dogs indicate the bone marrow responses in anemia. The indices, such as mean corpuscular volume and red blood cell distribution width, could provide valuable information in establishing diagnosis in anemic patients. These laboratory parameters were frequently overlooked in veterinary clinical practice (Zvorc *et al.,* 2010).

Severe anemia could cause obvious heterogeneity of the RBCs size and an increase in RDW level. Anemia was recognized as a well-documented risk factor in congestive heart failure (CHF), the potential mechanisms of which include inflammatory stress, inadequate production of erythropoietin and the impact of comorbidities (Förhécz *et al.,*

Table 1: Mean, standard error (SE) and Unpaired t-test values of anemic (n-194) vs healthy goats (n-7).

Parameters	Anemic goats (n -194) (Mean±SE)	Healthy goats (n -7) (Mean±SE)	*p* value	Reference value
RBC 10^6/µl	9.33±0.25	11.69±1.17	0.0806ns	8-18
HGB g/dl	5.24±0.13	11.96±1.00	<0.0001**	8-12
HCT%	13.01±0.32	28.43±3.70	<0.0001**	22-38
MCV fl	14.50±0.28	26.71±5.28	<0.0001**	16-25
MCH pg	5.89±0.11	11.03±1.63	<0.0001**	5.2-8
MCHC g/dl	41.08±0.46	42.64±5.22	0.5295ns	30-36
RDWs fl	20.60±0.33	25.11±3.76	0.0154*	
RDWc%	36.94±0.29	26.84±3.06	<0.0001**	21-29

p<0.05- Significant (*).

p<0.01- Highly significant (**).

ns- Non significant.

Table 2: Pearson's correlation coefficient values between RDW indices (RDWs and RDWc) and Hb, HCT, MCV and RBCs in anemic goats (n=194).

Parameters		RDWs	RDWc
MCV	r valve	0.8220	-0.4566
	p value	<0.0001**	<0.0001**
HCT	r valve	-0.1593	-0.3043
	p value	0.0265*	<0.0001**
HB	r valve	-0.2882	-0.2376
	p value	<0.0001**	0.0008**
RBCs	r valve	-0.4889	-0.06311
	p value	<0.0001**	0.3820ns

p<0.05- Significant (*).

p<0.01- Highly significant (**).

ns- Non significant.

2009). Elevations in RDW due to alterations in the osmolality of the circulating blood decreases the ability of red blood cells and undergo deformation under certain patho-physiological conditions resulting in low microvascular perfusion and later organ dysfunction. In this study Red blood cell distribution width (RDW) was recorded and compared among healthy and anemic goats. Erythrocytes play an important role in the transport of oxygen during blood circulation. Alteration of RBCs in volume and size would affect organ and tissue perfusions. RDW was found more sensitive than MCV in assessing the types of anemia and their prognosis (Neiger *et al.,* 2002). The estimation of RDW plays a pivotal role not only in anemia and but also in other organ disorders. The baseline RDW may have clinical significance for assessing clinical outcome and severity of various pathological conditions. A myriad of factors has an impact on red blood cell population dynamics which include production, maturation and turnover. A delay in the red blood cell clearance in pathological conditions might represent one of the leading determinants of increased anisocytosis.

CONCLUSION

Elevated red cell distribution width was recorded in anemic goats. Further studies on RDW could reveal new insights into inflammation mechanisms, disease diagnosis and their prognosis in goats.

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Conflict of interest: None.

REFERENCES

Cavaliere, T.A. (2004). Red blood cell indices: Implications for practice. Newborn Infant Nurs Newborn Infant Nurs Rev. 4: 231-239.

Förhécz, Z., Gombos, T., Borgulya, G., Pozsonyi, Z., Prohászka, Z. and Jánoskuti, L. (2009). Red cell distribution width in heart failure: Prediction of clinical events and relationship with markers of ineffective erythropoiesis, inflammation, renal function and nutritional state. American Heart Journal. 158: 659-666.

Guglielmini, C., Valentini, C.M., Contiero, B., Valente, C. and Poser, H. (2021). Red Cell Distribution Width Has a Negative Prognostic Role in Dogs with Myxomatous Mitral Valve Disease. Animals. 11(3): 778. doi: 10.3390/ani 11030778.

Hammarsten, O., Jacobsson, S. and Fu, M. (2010). Red cell distribution width in chronic heart failure: A new independent marker for prognosis? Eur. J. Heart Fail. 12: 213-214.

Lippi, G. and Plebani, M. (2014). Red blood cell distribution width (RDW) and human pathology. One size fits all. Clin. Chem. Lab. Med. 52: 1247-1249.

Martinez, C., Carmel, T., Mooney Robert, E., Shiel Pak Kan Tang, Louise Mooney. and Emma, O'Neill, J. (2019). Evaluation of red blood cell distribution width in dogs with various illnesses. Can. Vet. J. 60(9): 964-971.

Pastor, J., Cuenca, R., Velarde, R., Vinas, L. and Lavin, S. (1997). Evaluation of a hematology analyzer with canine and feline blood. Vet. Clin. Pathol. 26: 138-147.

Patel, K.V., Joy, G., Mohanty., Bindu Kanapuru., Charles Hesdorffer., William B Ershle. and Joseph M Rifkind. (2013). Association of the red cell distribution width with red blood cell deformability. Adv. Exp. Med Biol. 765: 211-216.

Piriyakhuntorn, P., Tantiworawit, A., Rattanathammethee, T., Chai-Adisaksopha, C., Rattarittamrong, E. and Norasetthada, L. (2018). The role of red cell distribution width in the differential diagnosis of iron deficiency anemia and non-transfusiondependent thalassemia patients. Hematology Reports. 10(3): 7605. doi: 10.4081/hr.2018.7605.

Neiger, R., Hadley, J. and Pfeiffer, U.D. (2002). Differentiation of dogs with regenerative and non-regenerative anaemia on the basis of their red cell distribution width and mean corpuscular volume. Vet. Rec. 6: 150(14): 431-434.

Salvagno, G.L., Sanchis-Gomar, F., Picanza, A. and Lippi, G. (2015). Red blood cell distribution width: A simple parameter with multiple clinical applications. Crit. Rev. Clin. Lab. Sci. 52: 86-105.

Semba, R.D., Patel, K.V., Ferrucci, L., Sun, K., Roy, C.N., Guralnik, J.M. and Fried, L.P. (2010). Serum antioxidants and inflammation predict red cell distribution width in older women: The Women's Health and Aging Study I. Clin. Nutr. 29(5): 600-604.

Souza, A.M., Camargo, M.B., Bacellar, D.T.L., Campos, S.D.E., Torres Filho, R.A., Alencar, N.X., Xavier, M.S., Macieira, D.B. and Almosny, N.R.P. (2012). Age and sex influence in canine red cell distribution Width (RDW-CV and RDW-SD) values. Rev. Bras. Ci. Vet. 19: 90-93.

Souza, Aline Pereira., Joylson Campos., Sabrina Bacellar., Daniela Torres., Rodolpho Macieira. and Daniel Almosny Nadia. (2017). Behavior of red cell distribution width (RDW) in a population of anemic and non-anemic dogs from an ambulatory care unit. Revista Brasileira de Ciência Veterinária. 24: 18-21.

Swann James, W., Siddharth Sudunagunta., Heather L Covey., Kate English., Anke Hendricks. and David J Connolly. (2014). Evaluation of red cell distribution width in dogs with pulmonary hypertension. Journal of Veterinary Cardiology. 16: 227-235.

Yang, J., Chuanmei, L., Lingling, L., Xiongwen, T. and Zhiwei, L. (2019). Red blood cell distribution width predicts pulmonary hypertension secondary to chronic obstructive pulmonary disease. Canadian Respiratory Journal. https://doi.org/10.1155/2019/3853454.

Zvorc, Z., Renata Bari dravko Zvorc., Renata BaricRafaj., Kules J Kules. and Vladimir Mrljak. (2010). Erythrocyte and platelet indices in babesiosis of dogs. Veterinarski Arhiv. 80(2): 259-267.