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# Profiling of hematological parameters due to seasonal variation in Sirohi goat

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## Abstract
The goal of the current study was to assess haematological parameters of Sirohi goats with response to 2 different seasons (hot humid and cold). We observed the overall mean value of various blood analytes i.e. haemoglobin, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration, packed cell volume, mean corpuscular volume, platelet count, plateletcrit, mean platelet volume in hot-humid and cold season remained as 8.36±0.15 and 8.73±0.3; 6.32±0.15 and 6.14±0.1; 21.76±0.15 and 20.53±0.16; 39.55±0.41 and 43.3±1.48; 29.4±0.85 and 31.14±0.6; 937.3±163.36 and 532.6±85.3; 0.79±0.16 and 0.43±0.8; 7.25±0.64 and 7.56±0.63, respectively.
A highly significant effect of hot- humid and cold was noticed on the mean value of mean corpuscular haemoglobin concentration. A significant effect of hot- humid and cold was observed on the mean value of packed cell volume, platelet count. A non-significant effect of hot- humid and cold was observed on the mean value of different blood analytes i.e. haemoglobin, mean corpuscular volume, mean corpuscular haemoglobin, mean platelet volume, plateletcrit.

**Keywords:** Sirohi goat, haemoglobin, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration, packed cell volume, mean corpuscular volume, platelet count, plateletcrit, mean platelet volume, seasons (hot humid and cold).

## Introduction
Complex interactions between climate and animal parameters are involved in the climatic effects on animal health and output. The main physical parameters affecting an animal's health and productivity include the environment's temperature, relative humidity, rain, radiant heat, air pressure, wind speed, and cold. The environment in which the goats are raised and their management system play a significant role in the success of goat farming. The combination of determination of different analytes in blood is helpful in bringing the commendable diagnosis for the welfare of animals, particularly Goat. Goats are considered highly suitable animals for rearing in harsh environments and stressful conditions. Animal's ability to adapt to a hot, humid, or cold climate depends on the integration of several physiological systems, including the nervous, endocrine, excretory, respiratory, and excretory systems. The adaptability of an animal to a hot, humid, or cold climate is measured by changes in morphological and physiological characteristics necessary for their survival. The breed differences evoke different responses to the various stressors in a specific environment, and depend on the degree of adaptation to that environment (Jindal, 1980) [19].
However, despite their extreme tolerance to environmental changes, the productivity of these animals often declines due to thermal stress (Al-Tamimi, 2007) [5]. Different species and breeds have different combinations and adaptations of numerous physiological systems that contribute to animals' improved capacity to adapt to extremely hot or cold climates. Efficient and synchronous coordination of the physiological system maintains the productive potential of domesticated animals under thermal stress (Marai and Habeeb, 2010) [21].
Hematological variables of blood are generally used to monitor and evaluate health and physiological status of ruminants (Chapple *et al*., 1991; Al-Eissa *et al*., 2012; Gupta *et al*., 2007) [10, 2, 17]. The biochemical and hematology profiles can also be used to assess the immunity status in goats (Al-Seaf and Al-Harbi, 2012) [4]. Hematological profile could be altered during seasonal variations (Abdelatif *et al*., 2009) [1]. Environmental elements, such as temperature and relative humidity, are known to have a significant impact on small ruminants' hematological profiles. (Balikci *et al*., 2007; Olayemi *et al*., 2009) [7, 25]. Sirohi goat breed is well adapted to the hot-dry climatic conditions of western and north-western India. Investigating the hematological parameters of Sirohi goats in two different seasons (hot humid and cold) was the goal of the current experiment.

## Material and Method
Blood Samples of adult female Sirohi Goat were taken in the hot-humid and cold season from the same animal (N=10). To evaluate the hematological parameters in Sirohi goats under seasonal change, a blood sample from each animal was taken on each given day of the month /season. Jugular vein blood samples (2 ml each) were taken aseptically with least stress to animals, directly into the EDTA vials to analyse different haematological parameters.

All haematological parameters were evaluated in the Department of Veterinary Physiology and Biochemistry, PGIVER, Jaipur, by using the Vet Spincell 5 Compact Automated Blood/ Hematology Analyzer. Following parameters were studied in the present study:

- Haemoglobin (Hb)
- Mean corpuscular haemoglobin (MCH)
- Mean corpuscular haemoglobin concentration (MCHC)
- Packed cell volume (PCV)
- Mean corpuscular volume (MCV)
- Platelet count (PLT)
- Plateletcrit (PCT)
- Mean platelet volume (MPV)

## Statistical Analysis
The findings were displayed as Mean± SE. The data was statistically evaluated using the t-test: Paired to Samples for Means and the findings were interpreted in accordance with Snedecor and Cochran (1994) [28].

**Table 1:** Mean± SE values of environmental variables (EVs) of Jaipur district of Rajasthan during varying environmental conditions

| Environmental Variables | Mean± SE values during varying environmental conditions | |
|---|---|---|
| | Hot-humid | Cold |
| $T_{min}$, ˚C | 22.40±0.12 | 10.27±0.09 |
| $T_{Max}$,˚C | 33.23±0.09 | 21.90±0.06 |
| $RH_{Min}$% | 41.00±0.58 | 31.50±0.29 |
| $RH_{Max}$% | 79.00±0.58 | 50.33±1.45 |
| $THI_{Min}$ | 67.64±0.19 | 53.34±0.11 |
| $THI_{Max}$ | 87.94±0.23 | 67.75±0.17 |

*THI -0.8 * ambient temperature + (relative humidity / 100) *(ambient temperature-14.3)) + 46.4
$T_{Min}$ - Minimum Temperature
$T_{Max}$ - Maximum Temperature
THI - Temperature Humidity Index
N - Number of Observation
RH - Relative Humidity
The following equation, suggested by NOAA (1976), was used to determine the corresponding temperature-humidity index (THI).

## Results and Discussion
The Blood analytes Hb, MCH and MCHC due to hot-humid and cold season have been shown in table 2 and depicted graphically in figure 1.

**Table 2:** Effect of Hot-humid and Cold Season on Mean ±SE values of Blood analytes Hb, MCH and MCHC in Sirohi Goat (N=10)

| Parameter | Season | Mean ± SE | Observation |
|---|---|---|---|
| Hb (g/dL) | Hot-humid | 8.36±0.15 | NS |
| | Cold | 8.73±0.30 | |
| MCH (pg) | Hot-humid | 6.32±0.15 | NS |
| | Cold | 6.14±0.10 | |
| MCHC (gm/dL) | Hot-humid | 21.76±0.15 | ** |
| | Cold | 20.53±0.16 | |

NS = Non-significant (P >0.05), * = Significant (*P*≤0.05), N = No. of Animals, ** = Highly Significant (*P*≤0.01)

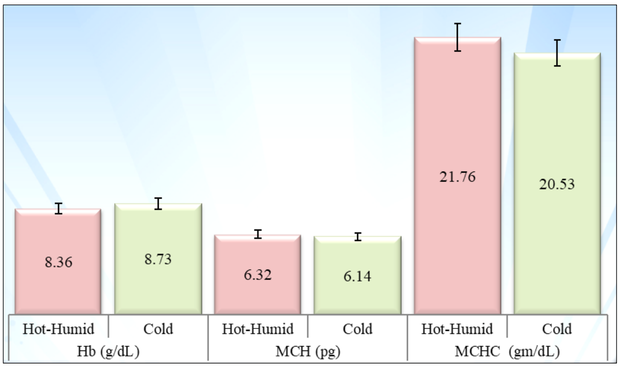


**Fig 1:** Mean ±SE values of Blood Hb, MCH, and MCHC according to the effect of Hot-humid and Cold in Sirohi Goat

### Hemoglobin (Hb)
The mean± SE values of haemoglobin (g/dl) in hot-humid and cold season were recorded as 8.36±0.15 and 8.73±0.3, respectively. The mean± SE value of haemoglobin was increased in cold season than hot-humid season but the effect was non-significant (*p*>0.05).

The observed mean± SE values of serum Hb in Goat were close to the range as illustrated by Dukes (2015) [29], although there was variation which might be due to the breed difference and different environmental conditions.

In context to present study, similar findings were reported by Ghosh *et al.* (2013) [14] as the haemoglobin (%) had a season dependent variation being high during winter than other seasons i.e. summer and monsoon in Goats but the effect was significant (*p*≤0.001). Abdelatif (2009) [1] reported that haemoglobin (g/dl) concentration was significantly increased in cold season in comparison to hot season in Goats. Banerjee *et al.* (2015) [8] reported that blood haemoglobin (g/dl) level was increased during winter and decreased during summer in all the breeds of Goats. Rahman *et al.* (2019) [27] observed that the highest haemoglobin (g/dl) value was recorded in winter than in summer in Goat. Giri, A. (2017) [15] reported significantly (*p*≤0.05) higher haemoglobin (g/dl) in winter (12.37±0.16) than summer (9.39±0.15) in cattle. Manjari *et al.* (2018) [20] estimated the highest value of haemoglobin (g/dl) concentration during winter and the lowest in summer in buffalo. In our study, the higher values of haemoglobin concentration obtained during cold in Goats could be attributed partly to high level of nutrition i.e. green fodder which might be related to iron supplementation.

Our findings were in contrary to Babe *et al.* (2015) [6] who reported that haemoglobin concentration was significantly (*p*≤0.05) increased in summer and autumn compared with other seasons (winter and spring) in Goats. Muthuramalingam *et al.* (2020) [22] observed that Tellicherry does had the highest haemoglobin (g/dl) concentration during the monsoon season (*P*≤0.01) followed by winter.

Gottam, G.S. (2020) [16] reported overall mean± SE concentration of haemoglobin (g/l) in female *Pugal* sheep as 143.20±0.21 and 113.90±0.20 in hot-humid/rainy and cold, respectively. A significant ($p≤0.05$) effect was observed on seasonal variation in the study. These values were also higher than reported value of both seasons during the study. This variation might be due to difference in species, breed, environmental condition and physiological status of individual animal.

**Mean corpuscular haemoglobin (MCH)**

The mean±SE values of MCH (pg) in hot-humid and cold season were recorded as 6.32±0.15 and 6.14±0.1, respectively. The mean±SE value of MCH was analyzed as increase in hot-humid as compared to cold season but the effect was non-significant ($p>0.05$).

The observed mean ± SE values of serum MCH were more or less close to the range as illustrated by Dukes (2015) [29], although there was variation which might be due to the difference in breed and environmental conditions.

Our findings were similar to the findings of Rahman *et al.* (2019) [27] who reported highest value of MCH (pg) in summer than winter in Goat but the effect was significant ($p≤0.05$). AL-Saeed MH *et al.* (2009) [3] reported the values of MCH (pg) as significantly ($p≤0.05$) higher in the summer than in the winter season in Cattle. Parmar, M. S. (2013) [26] reported that mean values of MCH (pg) were higher in summer season in Sahiwal cow and significantly ($p≤0.05$) higher in Murrah buffalo in comparison to winter season. The mean values were Unit (pg) 16.81±0.65, 14.67±0.57 for Murrah buffalo in summer and winter, respectively, and the mean values were 17.31±0.72, 17.14±0.42 for Sahiwal cow in summer and winter, respectively. The higher MCH values during hot-humid season in our study might be due to the release of the red blood cells from spleen or the increase in oxygen consumption due to tissue demand causing ESF (erythrocyte–stimulating factor) release.

Due to the decrease in total body water as a result of the rise in evaporative cooling, heat stress may have changed the blood's water content and viscosity. The relative increased MCH and MCHC could have been the outcome of hemoconcentration, which was possibly induced by this.

Present findings were contrary to Abdelatif (2009) [1] who reported highest mean value of MCH (pg)in winter season (8.05±0.79) in comparison to dry summer (7.75±0.95) and wet summer (7.72±0.99) in Goat.

Gottam, G.S. (2020) [16] observed overall mean±SE concentration of MCH (pg) in female *Pugal* sheep as 16.65±0.01and 17.71±0.01 in hot-humid/rainy and cold, respectively. A significant ($p≤0.05$) effect was observed on seasonal variation in the study. These values were higher than reported value for both seasons during the study. This variation might be due to different species, breed, environmental condition and physiological status of individual animal.

**Mean corpuscular haemoglobin concentration (MCHC)**

The mean±SE values of MCHC (gm/dl) in hot-humid and cold seasons were noted as 21.76±0.15 and 20.53±0.16, respectively. The mean±SE value of MCHC was shown highly significant ($p≤0.01$) increase in hot-humid compared to cold season.

The observed mean ± SE values of- serum MCHC were less close to the range as illustrated by Dukes (2015) [29], although there was variation which might be due to the breed difference and different environmental conditions.

Similar findings were reported by Oikonomidis *et al.* (2019) [24] as MCHC (gm/dl) was found increased during summer season as compared to winter season in rams. Parmar, M. S. (2013) [26] observed that mean value of MCHC (%) was higher in summer season in Sahiwal cow and significantly higher in Murrah buffalo in comparison to winter season where the mean values are 34.43±.2, 34.53±0.4 for Murrah buffalo in summer and winter, respectively. The mean values were 37.56±1.32 and 38.45±1.08 for Sahiwal cow in summer and winter, respectively. AL-Saeed MH *et al.* (2009) [3] reported that cattle had significantly ($p≤0.01$) higher MCHC (gm/dl) in the summer than in the winter season. In our study, the increased MCHC values during the hot, humid season were caused by the release of red blood cells from the spleen or a rise in oxygen consumption as a result of tissue demand, which led to the release of ESF (erythrocyte-stimulating factor).

Present findings were in contrast with the findings of Rahman *et al.* (2019) [27], who observed that highest MCHC (g/dl) value was recorded in winter than in summer in Goat. The values of MCHC were high in hot-humid or dry summer (32.16±1.26) than wet summer (32.15±1.07) and winter (32.06±1.34) in Goat according to Abdelatif (2009) [1].

Gottam, G.S. (2020) [16] measured overall mean±SE concentration of MCHC g/dl in female *Pugal* sheep as 32.97±0.15 and 36.37±0.14in hot-humid/rainy and cold, respectively. A significant ($p≤0.05$) effect was observed on seasonal variation in the study. These values were also higher than reported value for both seasons during the study. This variation might be due to different species, breed, environmental condition and physiological status of individual animal.

The Blood analytes PCV and MCV due to hot-humid and cold season have been shown in table 3 and illustrated in figure 2.

**Table 3:** Effect of Hot-humid and Cold Season on Mean ± SE values of Blood analytes PCV and MCV in Sirohi Goat (N=10)

| Parameter | Season | Mean ± SE | Observation |
|---|---|---|---|
| PCV (%) | Hot-humid | 39.55±0.41 | * |
| | Cold | 43.3±1.48 | |
| MCV (fl) | Hot-humid | 29.04±0.85 | NS |
| | Cold | 31.14±0.6 | |

N = No. of Animals
** = Highly Significant ($p≤0.01$)
NS = Non-significant ($p>0.05$)
* = Significant ($p≤0.05$)

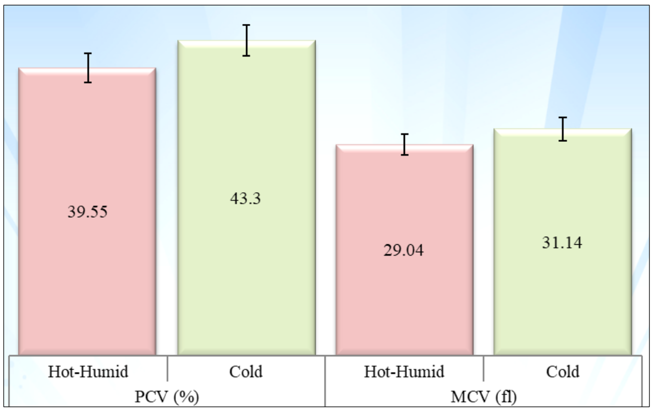


**Fig 2:** Mean ±SE values of Blood PCV and MCV according to the effect of Hot-humid and Cold in Sirohi Goat

**Packed cell volume (PCV)**

The mean± SE values of PCV (%) in hot-humid and cold season were observed as 39.55±0.41 and 43.3±1.48, respectively. The mean±SE value of PCV was found significantly ($p \leq 0.05$) higher in cold as compared to hot-humid season.

The observed mean±SE values of serum PCV in Goat were less than the range as illustrated by Dukes (2015) [29], although there was variation which might be due to the breed difference and different environmental conditions.

In present study, above stated findings were similar to Banerjee *et al.* (2015) [8] and Rahman *et al.* (2019) [27] who observed that blood PCV (%) levels increased during winter and decreased during summer in Goats. Manjari *et al.* (2018) [20] reported that the highest values of PCV (%) concentration were recorded during winter and the lowest in summer in buffalo. This could be the result of the body's high oxygen demand during the cold season, low blood oxygen partial pressure (hypoxemia), and higher metabolic rate (favoring high feed intake), all of which stimulate erythropoiesis and result in higher haematological values. The decrease in PCV may be caused by the depression of thyroid secretion, and the lower PCV during the hot-humid season as compared to the winter months may be brought on by heat stress brought on by the high relative humidity and ambient temperature during that time of year.

Present findings were dissimilar to Babe *et al.* (2015) [6] observed that PCV (%) was significantly increased ($p \leq 0.05$) in summer as compared with other seasons (winter and spring) in Goats. Muthuramalingam *et al.* (2020) [22] reported that Tellicherry does had the highest packed cell volume (PCV) % during the monsoon season ($p \leq 0.01$) followed by winter. Bhatta, A. (2014) [9] reported that highly significant effect of the seasonal variation on PCV (%) being higher in pre-monsoon (33.03±4.48) than post-monsoon (25.8±3.1) in Goat. Abdelatif *et al.* (2009) [1] reported that the values of PCV (%) has increased in wet summer in comparison to winter and dry summer, where the mean values of PCV were 28.95±2.22 (Wet summer), 28.24±2.51 (winter) and 26.25±2.51 (dry Summer) in Goat.

**Mean corpuscular volume (MCV)**

The mean±SE values of MCV (fl) in hot-humid and cold season were noted as 29.04±0.85 and 31.14±0.6, respectively. The mean±SE value of MCV was increased in cold than hot-humid season but the effect was non-significant ($p > 0.05$).

In present study, similar findings were reported by Abdelatif *et al.* (2009) [1] as mean values of MCV (fl) were 24.00±3.45, 25.12±2.80 and 24.12±3.42 in wet summer, winter and dry summer, respectively in Goat. Oikonomidis *et al.* (2019) [24] reported that MCV (fl) was found higher during winter season as compared to summer season in rams. AL-Saeed MH *et al.* (2009) [3] and Giri, A. (2017) [15] observed that cattle had significantly ($P \leq 0.01$) higher MCV(fl) in the winter than in the summer season. Manjari *et al.* (2018) [20] noted that MCV values were significantly higher in thermo-neutral and winter samples than that of summer in buffalo. Increased MCV in the cold season might be due to the more feeding of concentrate and hay Lucerne which is rich in minerals and decreased MCV in the hot-humid might be seen in iron deficiency or chronic blood loss conditions.

Present findings were in contrast to the findings of Rahman *et al.* (2019) [27] reported the highest values of MCV in summer than winter in Goat.

Gottam, G.S. (2020) [16] reported overall mean±SE concentration of MCV (fl) in female *Pugal* sheep as 45.97±0.11 and 44.69±0.11 in hot-humid/rainy and cold, respectively. A significant ($p \leq 0.05$) effect was observed on seasonal variation in the study. These values were higher than reported values in both seasons during the study. This variation might be due to difference in species, breed, environmental condition and physiological status of individual animal.

The mean± SE values of Blood PLT, PCT and MPV due to hot-humid and cold season have been shown in table 4 and depicted graphically in figure 3.

**Table 4:** Effect of Hot-humid and Cold Season on Mean ±SE values of Blood Analytes PCT, PLT and MPV in Sirohi Goat (N=10)

| Parameter | Season | Mean ± SE | Observation |
|---|---|---|---|
| PLT (10*3/µl) | Hot-humid | 937.3±163.36 | * |
| | Cold | 532.6±85.3 | |
| PCT (%) | Hot-humid | 0.79±0.16 | NS |
| | Cold | 0.43±0.08 | |
| MPV (fl) | Hot-humid | 7.25±0.64 | NS |
| | Cold | 7.56±0.63 | |

NS = Non-significant ($P > 0.05$)
** = Highly Significant ($P \leq 0.01$)
* = Significant ($P \leq 0.05$)
N = No. of Animals

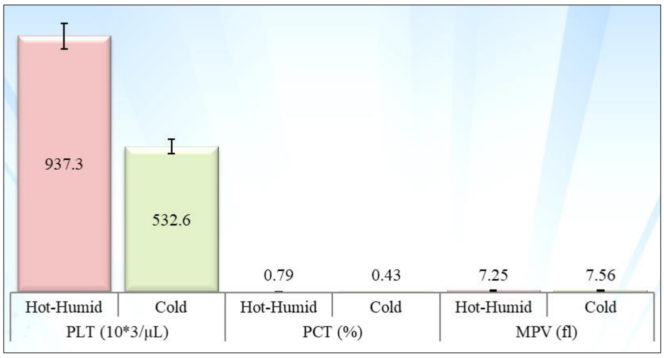


**Fig 3:** Mean ±SE values of Blood PLT, PCT and MPV according to the effect of Hot-humid and Cold in Sirohi Goat

**Platelet count (PLT)**

The mean±SE values of PLT ($10*^3/\mu L$) in hot-humid and cold season were analyzed as 937.3±163.36 and 532.6±85.3, respectively. The mean ± SE values of PLT were significantly ($p \leq 0.05$) lower in cold as compared to hot- humid season.

The observed mean± SE values of platelet count were more or less close to the range as illustrated by Schalm's Veterinary Hematology (2010) [11]. Although, there was variation might be due to the difference in breed and environmental conditions.

Gottam, G.S. (2020) [16] observed overall mean ±SE concentration of PLT in female *Pugal* sheep as 495.00±0.44 ($10^{-9}$ L) and 414.00±0.56 ($10^{-9}$ L) in hot-humid/rainy and cold, respectively. A significant ($p \leq 0.05$) effect was observed on seasonal variation in the study.

Habibu *et al.* (2017) [18] reported the platelet count ($10*^9$/L) was significantly higher in pregnant compared with non-pregnant goats as pregnancy is one of the important stress factor like climatic stressors. The difference in climate and season is likely responsible for the physiological and haematological variation in goat.

Present findings were contrary to Giri, A. (2017) [15] who reported significantly higher PLT ($10*^3/\mu L$) in winter

(461.18±23.20) than summer (298.26±15.56) in cattle. Enculescu *et al.* (2017) [12] observed that higher values of PLT (mii/mm3) were shown in winter compared to summer season in buffalo. Gallerani *et al.* (2013) [13] observed that seasonal analysis showed higher values of PLT ($10^{*9}$/L)in winter to autumn than in summer in human.

As they are not well acclimated to cold climates, Sirohi goats may become hypothermic when exposed to low ambient temperatures, which puts them at risk for developing thrombocytopenia. Thrombocytopenia is a result of chronic liver disease. It is due to lowered formation of thrombopoietin in the insulated liver. More destruction of platelet via phagocytosis inflamed the spleen.

**Plateletcrit (PCT)**

The mean± SE values of PCT (%) in hot-humid and cold season were recorded 0.79±0.16 and 0.43±0.08, respectively. The mean±SE value of PCT was increased in hot-humid than cold season but the effect was non-significant ($p>0.05$).

In present study, similar findings were reported by Oikonomidis *et al.* (2019) [24] as PCT (%) was found higher during summer season as compared to winter season in rams.

Present findings were contrary to Enculescu *et al.* (2017) [12] as higher values of PCT (%) have been shown in winter compared to summer season in Buffalo.

Variations in PCT in respect to Goats may be attributed to differences in environmental conditions as well as nutritional factors. It is also concluded with no definite reason, but it might be due to certain factors like physiological and metabolic status of individual etc.

**Mean platelet volume (MPV)**

The mean± SE values of MPV (fl) in hot-humid and cold season were recorded as 7.25±0.64 and 7.56±0.63, respectively. The mean±SE value of MPV (fl) was increased in cold than hot-humid season but the effect was non-significant ($p>0.05$).

Similar findings were observed by Oikonomidis *et al.* (2019) [24] that the MPV (fl) was found higher during winter season as compared to summer season in rams. The mean platelet volume is expected to be increased in response to thrombocytopenia.

Contrary conclusions were found by Enculescu *et al.* (2017) [12] who observed higher values of MPV (fl) in summer compared to winter season in buffalo.

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