



## Blood, metabolic and oxidative profiles in cows during the transition period

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### ABSTRACT

Two hundred and twenty-five cows were randomly selected from organized and unorganized farms in the Jammu region of the Union Territory of Jammu and Kashmir, India. In these dairy cows, the serum biochemical and hematological parameters were studied from late pregnancy to the early postpartum period. The animals in the study were divided into three groups, with 75 animals in each group: group I (3 weeks pre-partum period), group II (3 weeks post-partum) and group III (dry animals), and subjected to hemato-biochemical and oxidative profiling. Whole blood samples and serum blood samples were collected for hematological, biochemical, and oxidative analysis, which included total proteins, glucose, creatinine, cholesterol, albumin, globulin, malondialdehyde (MDA), catalase (CAT), glutathione peroxidase (GPx), superoxide dismutase (SOD), and serum Ca, Mg, Na, K and P. Significant changes were observed in the biochemical and hematological parameters (RBCs, hemoglobin, MCV, MCHC, monocyte count and total proteins, albumin and globulin) between the pre- and post-partum periods. In regard to oxidative stress, there was an increase in MDA in group II ( $6.10 \pm 0.44$ ) in comparison to groups I and III ( $6.07 \pm 0.57$  and  $5.54 \pm 0.34$ ). Marked changes in hemato-biochemical and oxidative stress markers were reported during the period of late pregnancy and the onset of lactation, causing a significant effect on the dairy cows' health, immune status and disorder receptiveness.

**Key words:** transition period; hematology; protein profile; oxidative status

### Introduction

The transition period is the time from three weeks before calving to three weeks after calving ([PRAVEEN and DHAARANI, 2018](#)). It is marked by changes in metabolic and immune functions in animals ([PICCIONE et al., 2012](#)). During this pe-

riod, animals have higher metabolic demands and stress due to numerous physiological and biochemical alterations in their bodies. Negative energy balance (NEB) and mobilization of fat (non-esterified fatty acids) (NEFA) will ensue in the transition period ([WANKHADE et al., 2017](#)). During

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this period, the use of body fat to supply the body's energy deficiency ([DRACKLEY, 1999](#)) causes significant aggregation of NEFA, further increasing liver uptake, and leading to significant aggregation of triglycerides in hepatocytes. This further leads to fatty liver, increasing the danger of postpartum disturbances in cows ([SHEEHY et al., 2017](#); [HERDT, 2000](#); [PAIANO et al., 2020](#)). This causes the development of reactive oxygen species (ROS) due to the negative energy balance. In spite of the fact that ROS are not harmful and are normally produced in metabolic processes, they may cause oxidative stress when in considerable amounts, or when formed rapidly to the level that antioxidant mechanisms can no longer reduce them ([HALLIWELL, 2006](#)). Various changes in biochemical and hematological parameters are used to assess metabolic disruptions in the transition period in cows ([EL-DEEB and EL-BAHR, 2017](#)). Therefore, the present study was undertaken to assess the changes in hemato-biochemical, metabolic and oxidative parameters in the transition period in cows.

## Materials and methods

*Experimental animals.* The experiment was conducted during 2018-2021 at the Division of Veterinary Medicine of the Faculty of Veterinary Sciences and Animal Husbandry, Sher-e Kashmir University of Agricultural Sciences and Technology, Jammu. The cows (n=225) in the transition period, with parity ranging from 1 to 4, aged 3 to 14 years, were randomly selected from unorganized and organized dairy farms in the Jammu region, UT, Jammu and Kashmir, India. They were categorized into three groups of 75 animals each: group I (3 weeks pre-partum period), group II (3 weeks post-partum) and group III (dry animals). In the organized farms, the animals were reared under standard feeding management and a semi-intensive housing system. The cows were provided stall feeding with 25-30 kg of dry fodder (paddy and wheat straw).

*Blood samples.* Hematological parameters were evaluated as follows: total WBC ( $10^3/\mu\text{L}$ ), lymphocytes (%), monocytes (%), granulocytes (%), RBC ( $10^6/\mu\text{L}$ ), Hb (g/dl), HCT(%), MCV (fl),

MCH (pg), MCHC (pg) and platelets ( $10^3/\mu\text{L}$ ). Blood samples were collected in vacutainers containing EDTA (Ethylene diamine tetra acetic acid) (VACUETTE (Cat. 455036, Greiner bio-one, Austria) using a MYTHIC 18 VET Hematology Analyzer, (Compact diagnostics India Pvt Ltd.) and for estimation of biochemical parameters, samples were collected in serum clot activator vacutainers. Immediately after sampling, blood glucose levels were evaluated using an Accu-check glucometer.

*Blood biochemical analysis.* The biochemical parameters: total protein (g/dl), HDL (mg/dl), calcium (mg/dl), cholesterol (mg/dl), globulin (g/dl), albumin (g/dl) were evaluated by UV spectrophotometer using Erba diagnostic kits (Transasia Biomedical Ltd. Mumbai, India), for blood electrolytes, sodium, and potassium Liquizyme kits (Beacon Diagnostics Pvt. Ltd. Navsari, India) were used, and for inorganic phosphorus Agappe diagnostic kits (Ernakulam, Kerala, India).

*Oxidative stress.* Oxidative stress markers, such as superoxide dismutase (SOD), glutathione peroxidase (GPx), lipid peroxidase (LPO), and catalase, were evaluated in the transition cows and the control group (mid-lactation). Malondialdehyde production was evaluated for determination of lipid peroxidation in erythrocytes ([REHMAN, 1984](#)). The plasma catalase activity was estimated according to the method described by [AEBI \(1983\)](#). Erythrocytic superoxide dismutase activity was determined by [MARKLUND and MARKLUND \(1974\)](#) method. Superoxide dismutase activity was measured in SOD units/mg protein. In the erythrocytes, the activity of glutathione peroxidase was assayed according to [HAFEMAN et al. \(1974\)](#).

*Body condition score (BCS).* The animals were examined to record their body condition score (BCS). Body condition is the amount of reserves in a live animal. The BCS of each cow was assessed on a scale of 0 to 5 points ([FERGUSON et al., 1994](#)) indicating emaciated, poor, thin, moderate, average, good and fatty animals. Seven body check points were examined, including the loin (short ribs) (spinous process and transverse process), hook bone, rump, tail head ligament, and sacral ligament and pin bone. The cows were classified into three groups: average or good condition, inferior

condition, and superior condition cows. Average or good condition cows were scored between 3- and 3+, inferior condition and superior condition cows were scored between  $\leq 2+$  and  $\geq 4$ , respectively (MISHRA et al., 2016).

*Statistical analysis.* All data were analysed statistically using ANOVA. The data were represented as Mean $\pm$  SE.

## Results and discussion

*Hematological changes during the transition period.* In combination with clinical examination or other diagnostic procedures, hematology is an informative diagnostic tool in veterinary medicine (ROLAND et al., 2014). The mean $\pm$ SE values of hematological parameters in all three groups (Group I, II and III) are depicted in Table 1. The mean  $\pm$  SE values of WBC ( $\times 10^3/\mu\text{l}$ ) in all the groups were elevated, with the highest values in group III (13.84 $\pm$ 17.40). The WBC, lymphocytes, RBC, hemoglobin and MCHC were higher in group I cows. The higher values of RBC in group I than group II could be due to over-production of adrenaline due to the stress of parturition (RANI and RAO, 2021). The transition stage not only affects the cows' clinical condition, but also significantly affects their internal hemogram, including RBC, hemoglobin, WBC, Lymphocytes and MCV (GHANEM et al.,

2012). The hemoglobin content (g/dl) showed a non-significant decrease in group I and group II that was attributed to anemia due to the stress of pregnancy and parturition (DARAMOLA et al., 2004). In group II, the lower hemoglobin values could be due to the lower erythropoiesis in this group (KUMAR and PACHAURI, 2000). The lower level of lymphocytes in group II may be due to increased serum cortisol around parturition (PREISLER et al., 2000). The MCV values differed significantly between the groups.

*Biochemical changes during the transition period in cows.* The mean $\pm$ SE concentrations of albumin, total protein and globulin differed non-significantly between group I and II. Serum globulins showed a non-significant decrease during the transition period. This could be due to the production of colostrum, and immunological changes that occur around parturition (JANKU et al., 2011). In our study, the cholesterol levels showed non-significant differences ( $P < 0.05$ ) between different transition stages, which coincides with the study by SINGH et al. (2012). On the other hand, a higher serum cholesterol concentration during the pre-calving period was reported by ABAYAWANSA et al. (2013). High demand for placental steroid and adrenal corticosteroid synthesis, and colostrum and milk synthesis could be the reason for the low concentration of cholesterol at calving.

Table 1. Mean  $\pm$  SE values of different hematological indices in different stages of transition

| Parameters                        | -30 days (Gp-I) (n=75)<br>(Prepartum) | +30 days (Gp-II) (n=75)<br>(Postpartum) | Control (Gp-III) (n=75)<br>(Dry animals) |
|-----------------------------------|---------------------------------------|---|--|
| WBC ( $\times 10^3/\mu\text{L}$ ) | 8.78 $\pm$ 9.49 <sup>a</sup>          | 6.58 $\pm$ 1.32 <sup>a</sup>            | 13.84 $\pm$ 17.40 <sup>b</sup>           |
| Lymphocytes (%)                   | 64.86 $\pm$ 15.45 <sup>a</sup>        | 63.72 $\pm$ 11.15 <sup>a</sup>          | 62.20 $\pm$ 23.24 <sup>a</sup>           |
| Monocytes (%)                     | 6.17 $\pm$ 2.44 <sup>ab</sup>         | 6.81 $\pm$ 2.46 <sup>b</sup>            | 5.76 $\pm$ 2.45 <sup>a</sup>             |
| Granulocyte (%)                   | 29.44 $\pm$ 16.66 <sup>a</sup>        | 30.44 $\pm$ 12.02 <sup>a</sup>          | 32.16 $\pm$ 24.59 <sup>a</sup>           |
| RBC ( $\times 10^3/\mu\text{L}$ ) | 5.25 $\pm$ 1.13 <sup>ab</sup>         | 4.93 $\pm$ 1.19 <sup>a</sup>            | 5.45 $\pm$ 1.29 <sup>b</sup>             |
| Hb (g/dl)                         | 6.99 $\pm$ 2.90 <sup>a</sup>          | 6.8 $\pm$ 1.08 <sup>a</sup>             | 7.75 $\pm$ 4.09 <sup>a</sup>             |
| HCT (%)                           | 24.91 $\pm$ 4.38 <sup>a</sup>         | 25.66 $\pm$ 2.85 <sup>a</sup>           | 25.03 $\pm$ 5.68 <sup>a</sup>            |
| MCV (fl)                          | 50.18 $\pm$ 9.62 <sup>a</sup>         | 56.54 $\pm$ 7.31 <sup>b</sup>           | 46.70 $\pm$ 8.17 <sup>c</sup>            |
| MCH (pg)                          | 13.77 $\pm$ 6.16 <sup>a</sup>         | 14.14 $\pm$ 1.93 <sup>a</sup>           | 14.54 $\pm$ 8.87 <sup>a</sup>            |
| MCHC (pg)                         | 27.25 $\pm$ 9.53 <sup>ab</sup>        | 25.03 $\pm$ 1.16 <sup>a</sup>           | 30.7 $\pm$ 15.87 <sup>b</sup>            |
| PLT ( $\times 10^3/\mu\text{L}$ ) | 431.96 $\pm$ 217.79 <sup>a</sup>      | 534.34 $\pm$ 182.48 <sup>a</sup>        | 484.78 $\pm$ 472.54 <sup>a</sup>         |

Means bearing different superscripts (a,b,c) differ significantly from each other ( $P < 0.05$ )

The creatinine levels differed significantly between group I and group II. Our results coincided with the findings of [GHANEM et al. \(2012\)](#) who reported elevated creatinine levels near calving. Similar findings were observed by [PICCIONE et al. \(2012\)](#), who found higher serum creatinine levels in late gestation compared to the second week of lactation. Creatinine levels rise around parturition due to the circulation of the fetal membrane, and the quantity of organic waste from the new born ([ROUBIES et al., 2006](#)). The calcium levels showed a non-significant decrease between group I and group II, but a significant difference was observed between group III and the other two groups (groups I and II). Similar findings for calcium levels were observed by [ZEINAB \(2007\)](#) and ([HAGAWANE et al., 2009](#)), who suggested that the deficiency may be due to improper food, metabolite absorption from the GI tract, insufficient mobilization of calcium from the skeleton, excessive calcium loss in urine, and draining of a high percentage of calcium and phosphorus in the colostrum soon after birth.

Potassium levels did not differ significantly between the groups. The sodium level was significantly higher in group III and lowest in group II, which may be due to its secretion in colostrum and milk ([DARAMOLA et al., 2004](#); [GHANEM et al., 2012](#)).

*Changes in oxidative stress markers during the transition period in cows.* Oxidative stress in-

dicates an imbalance between oxidant and antioxidant levels, and an increase in the risk of metabolic and infectious diseases by causing a malfunction in inflammatory responses. Oxidative stress can be calculated by biological markers, such as malondialdehyde (MDA), glutathione peroxidase (GPx) and potential antioxidant capacity (PAO). The result of lipid peroxidation is MDA. Further, it increases after parturition in cows ([TSUCHIYA et al., 2020](#)). The present study showed an increase in the mean  $\pm$  SE values of malondialdehyde (MDA) (n moles of MDA produced/ g of Hb hr) in group II ( $6.10 \pm 0.44$ ) in comparison to groups I and III ( $6.07 \pm 0.57$  and  $5.54 \pm 0.34$ ). Our findings coincide with the findings of [SHARMA et al. \(2011\)](#).

Blood serum catalase (CAT) levels in the three groups (I, II, and III) were  $38.53 \pm 6.21$ ,  $37.88 \pm 3.50$ , and  $50.21 \pm 7.40$ , respectively. The data showed the highest values in the control group. The mean  $\pm$  SE values of superoxide dismutase (SOD, U/ mg of Hb) in groups I, II, and III were  $6.44 \pm 0.32$ ,  $6.36 \pm 0.35$  and  $6.22 \pm 0.23$ , respectively. The study showed a decrease in values from group I to group III, with the highest level in group I (Table 3). Similar findings were observed by [NAKOV et al. \(2016\)](#). [MAURYA et al. \(2014\)](#) reported increased SOD in animal blood after parturition in comparison with the period of advanced gestation. The blood serum glutathione peroxidase (GPx, mg/Hb) level was highest in group I ( $1.83 \pm 0.16$ ), followed

Table 2. Biochemical changes during the transition period in cows

| Parameters           | -30 days (Gp-I) (n=75) | +30 days (Gp-II) (n=75)<br>(Postpartum) | Control (Gp-III) (n=75)<br>(Dry animals) |
|----------------------|------------------------|---|--|
| Albumin (g/dl)       | $3.01 \pm 0.26^a$      | $2.96 \pm 0.24^a$                       | $3.11 \pm 0.92^a$                        |
| Total protein (g/dl) | $6.22 \pm 0.89^a$      | $5.99 \pm 0.55^a$                       | $6.69 \pm 1.61^b$                        |
| Globulin (g/dl)      | $3.21 \pm 0.93^a$      | $3.02 \pm 0.64^a$                       | $3.80 \pm 1.98^b$                        |
| Cholesterol (mg/dl)  | $204.28 \pm 57.87^a$   | $188.52 \pm 30.95^a$                    | $210.82 \pm 86.24^a$                     |
| Creatinine (mg/dl)   | $1.77 \pm 0.72^a$      | $1.52 \pm 0.67^b$                       | $1.34 \pm 0.41^b$                        |
| HDL (mg/dl)          | $115.34 \pm 79.88^a$   | $79.64 \pm 55.65^a$                     | $198.19 \pm 135.40^b$                    |
| Calcium (mg/dl)      | $8.54 \pm 1.16^a$      | $8.23 \pm 0.86^a$                       | $9.90 \pm 4.08^b$                        |
| Sodium (mEq/L)       | $164.64 \pm 23.95^a$   | $160.17 \pm 13.71^a$                    | $202.58 \pm 105.31^b$                    |
| Potassium (mEq/L)    | $4.42 \pm 1.20^a$      | $4.37 \pm 0.69^a$                       | $4.24 \pm 1.51^a$                        |
| Phosphorus (mg/dl)   | $8.80 \pm 3.50^a$      | $7.88 \pm 0.92^{ab}$                    | $7.92 \pm 3.51^b$                        |

Means bearing different superscripts (a,b,c) differ significantly from each other (P<0.05)

by groups II and III ( $1.75\pm 0.08$  and  $1.14\pm 0.04$ ), respectively. There was a decline in the values from group I to III. Our findings coincide with the findings of [SHARMA et al. \(2011\)](#), who reported that GPx values decreased in early lactation in comparison with advanced pregnancy.

*Changes in body condition score (BCS) and glucose levels in blood during the transition period.* Although a slight decline in the prepartum BCS is a warning of a postpartum risk of significant changes in the BCS, more outstanding health issues, and a subpar performance in terms of productivity, it may be simple for primiparous cows to achieve an ideal BCS at calving through sufficient prepartum management. Additionally, in cows with deficient BCS, concurrent hormone levels prevent excessive lipolysis and metabolic illness, indicating that their physiological function is appropriate, and secretion of hormones is sufficient to meet the postpartum demand. The mean $\pm$ SE of BCS in the three groups revealed a decrease in values, i.e.  $2.86\pm 0.33$ ,  $2.65\pm 0.59$  and  $3.05\pm 0.43$ , in group I, group II, and group III, respectively, suggestive of reduced BCS from prepartum to the post-partum period. Similar findings were observed by [ALHAR-](#)

[THI et al. \(2018\)](#), [TORRES et al. \(2020\)](#), [BREDA et al. \(2023\)](#) who concluded that no change in BCS was observed until calving, and it decreased during early lactation. [COLAKOĞLU et al. \(2020\)](#) concluded in their study that cows with lower BCS in the prepartum period had poor metabolic and oxidative balance during the transition period. A decrease in BCS during early lactation is common because of the mobilization of body reserves (fat and protein) to meet the demands of milk production ([BARLETTA et al., 2017](#)). Further, glucose levels were significantly higher in group I in comparison to groups II and III. The increase in the level of glucose at calving may be due to increased hepatic gluconeogenesis ([REYNOLDS et al., 2003](#)). The need for glucose increases significantly after calving, and cows make adjustments to this need by gluconeogenesis, using propionates, amino acids and glycerol ([DRACKLEY et al., 2001](#)). The brief decrease in glucose levels in the first week of lactation may be due to the increased requirement for glucose for lactose synthesis, and inadequate gluconeogenesis ([DOEPEL et al., 2002](#)) because the decrease in energy could not be fully compensated for by energy intake.

Table 3. Oxidative biomarkers and anti-oxidant levels during the transition period in cows

| Parameters  | -30 days (Gp-I) (n=75) (Prepartum) | +30 days (Gp-II) (n=75) (Postpartum) | Control (Gp-III) (n=75) (Dry animals) |
|---|------------------------------------|--------------------------------------|---------------------------------------|
| MDA (moles of MDA produced/g of Hb /hr)                     | $6.07\pm 0.57^b$                   | $6.10\pm 0.44^b$                     | $5.54\pm 0.34^a$                      |
| CAT ( $\mu$ moles of $H_2O_2$ utilised $min^{-1} mg^{-1}$ ) | $38.53\pm 6.21^a$                  | $37.88\pm 3.50^a$                    | $50.21\pm 7.40^b$                     |
| SOD (Units /mg of Hb)                                       | $6.22\pm 0.23^a$                   | $6.36\pm 0.35^b$                     | $6.22\pm 0.23^a$                      |
| GPx (mg/Hb)   | $1.83\pm 0.16^a$                   | $1.75\pm 0.08^b$                     | $1.14\pm 0.04^c$                      |

Means bearing different superscripts (a,b,c) differ significantly from each other ( $P<0.05$ )

Table 4. Profile of body condition score during the transition period in cows

| Parameters | -30days (Gp-I) (n=75) (Prepartum) | +30days (Gp-II) (n=75) (Postpartum) | Control (Gp-III) (n=75) (Dry animals) |
|------------|-----------------------------------|-------------------------------------|---------------------------------------|
| BCS        | $3.05\pm 0.43^a$                  | $2.86\pm 0.33^b$                    | $2.65\pm 0.59^c$                      |
| Glucose    | $60.41\pm 6.37^b$                 | $56.43\pm 4.55^a$                   | $59.41\pm 8.67^b$                     |

Means bearing different superscripts (a,b,c) differ significantly from each other ( $P<0.05$ )

## Conclusions

Marked changes in hemato-biochemical and oxidative stress markers were reported during the period of late pregnancy and the onset of lactation, causing a significant effect on the dairy cows' health, immune status and disease receptiveness.

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## Authorship contribution statement

S.K. and N.S.: Conceptualized the idea and collected the samples and analysis, and manuscript writing; SK: analysis of oxidative parameters; N.B.: statistical data analysis and manuscript editing.

## Declaration of competing interest

No potential conflict of interest is reported by the authors

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## Availability of data and material

Data are available from the corresponding author and may be provided on reasonable request.

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**KOUR, S., N. SHARMA, S. KOUR, N. BALAJI, M. S. BHADWAL: Krvni, metabolički i oksidacijski profili u krava u prijelaznom razdoblju. *Vet. arhiv* 95, 393-400, 2025.**

#### SAŽETAK

U pokrajini Jammu, ujedinjeni teritorij Jammu i Kašmira iz Indije, na farmama s različitim uzgojem goveda nasumično je odabrano 225 krava. Istraženi su biokemijski i hematološki pokazatelji u serumu mliječnih krava u razdoblju od kasne gravidnosti do ranog poslijeporođajnog perioda. Životinje su podijeljene u tri skupine po 75 jedinki: Skupina I (3 tjedna prije porođaja), skupina II (3 poslije porođaja) i skupina III (suhostaj). Analizirani su pokazatelji za hematološki, biokemijski i oksidacijski status, što je obuhvaćalo ukupne proteine, glukozu, kreatinin, kolesterol, albumin, globulin, malondialdehid (MDA), katalazu (CAT), glutation-peroksidazu (GPx), superoksid-dismutazu (SOD) te serumski Ca, Mg, Na, K i P. Između prijeorođajnog i poslijeporođajnog razdoblja utvrđene su znakovi- te promjene u vrijednostima sljedećih biokemijskih i hematoloških pokazatelja: broj eritrocita, hemoglobin, MCV, MCHC, broj monocita te ukupni proteini, albumin i globulin. Što se tiče oksidacijskog stresa, ustanovljen je porast MDA u skupini II ( $6,10 \pm 0,44$ ) u usporedbi sa skupinama I i III ( $6,07 \pm 0,57$  i  $5,54 \pm 0,34$ ). Zabilježene promjene u hemato-biokemijskim pokazateljima kao i pokazateljima oksidacijskog stresa, u vrijeme kasne gravidnosti i početka laktacije, znatno su utjecale na zdravlje mliječnih krava, imunosni status i prijemljivost za bolesti.

**Ključne riječi:** krava; prijelazno razdoblje; hematologija; profil proteina; oksidacijski status

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