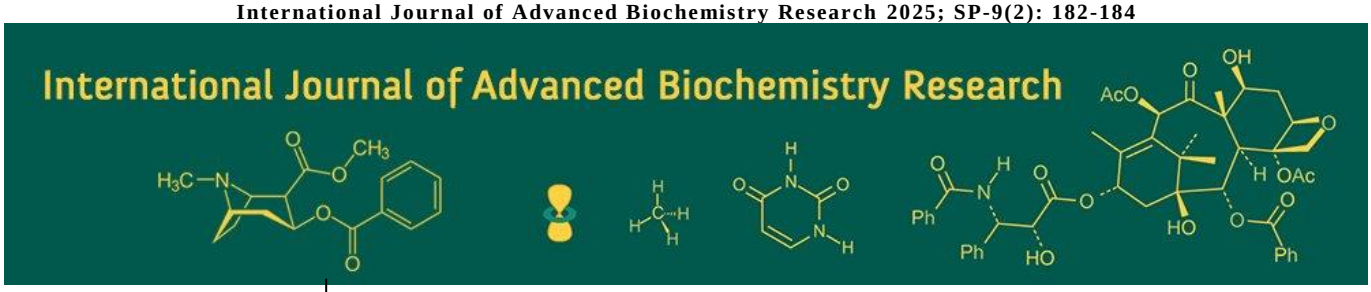


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# Hematological alterations in *Cryptosporidium* infected calves

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**Abstract**
Livestock is an integral part of the agricultural production system in the Indian economy and the socio-economic development of millions of rural households. Diarrhoea is a leading cause of death in calves under six months old, resulting in significant economic losses to the cattle industry. Various pathogens, including bacteria, viruses, protozoa, and intestinal parasites, can cause diarrhoea in calves. Among these, *Cryptosporidium* species are widely recognized as the most common pathogens responsible for diarrhoea in calves, surpassing other enteric infections like rotavirus, bovine coronavirus, and enterotoxigenic *Escherichia coli*. These species exhibit a distinct age-related distribution in bovine hosts, with *Cryptosporidium parvum* (*C. parvum*) being the most prevalent in pre-weaned calves (1-3 months old) across various countries. In contrast, *C. bovis* and *C. ryanae* are more commonly found in calves aged 3 to 11 months. Additionally, *C. parvum* infection is considered a significant zoonotic risk, as it often causes watery diarrhoea in newborn calves and can be easily transmitted to humans. Hematological analyses are essential tools for diagnosing diseases, making medical decisions, and providing valuable insights during the diagnostic process. By comparing the test results from affected animals with the normal reference values of healthy animals, these analyses help in identifying abnormalities and guiding appropriate treatment strategies. Several parameters are recognized or suggested as useful indicators of a calf's susceptibility to illness or death. Among these are the total red blood cell count (tRBC), hemoglobin (Hb) levels, and packed cell volume (PCV), which are commonly used to assess the animal's health status.

**Keywords:** *Cryptosporidium parvum*, diarrhoea, calves, hematological analysis, red blood cell count, hemoglobin levels

## Introduction
Livestock is an integral part of the agricultural production system in Indian economy as well as in socio-economic development of millions of rural households. Diarrhoea, being the leading cause of death in calves aged less than six months, is a major source of economic loss to the cattle industry. It can be caused by a variety of pathogens including bacteria, viruses, protozoa and intestinal parasites.

*Cryptosporidium* species are widely recognized as the most common pathogens responsible for diarrhoea in calves, surpassing other enteric infections like rotavirus, bovine coronavirus, and enterotoxigenic *Escherichia coli* (Karanis *et al*., 2010) [3]. These species exhibit a distinct age-related distribution in bovine hosts, with *Cryptosporidium parvum* (*C. parvum*) being the most prevalent in pre-weaned calves (1-3 months old) across various countries. In contrast, *C. bovis* and *C. ryanae* are more commonly found in calves aged 3 to 11 months (Qi *et al.* 2020) [6].

Additionally, *Cryptosporidium parvum* infection is considered a significant zoonotic risk, as it often causes watery diarrhoea in newborn calves and can be easily transmitted to humans. Hematological analyses are essential tools for diagnosing diseases, making medical decisions, and providing valuable insights during the diagnostic process. By comparing the test results from affected animals with the normal reference values of healthy animals, these analyses help in identifying abnormalities and guiding appropriate treatment strategies (Shehata *et al.* 2024) [8]

Several parameters are recognized or suggested as useful indicators of a calf's susceptibility to illness or death.

Among these are the total red blood cell count (tRBC), hemoglobin (Hb) levels, and packed cell volume (PCV), which are commonly used to assess the animal's health status (Lykkesfeldt and Svendsen, 2006) [4].

## Materials and Methods

Blood was collected aseptically by jugular veni puncture. Five milliliters of blood of 20 infected and 10 healthy calves were collected in EDTA coated vials (Accuvete-PLUS, Quantum biologicals Pvt. Ltd) for complete blood count. Haematology was performed within 10 h of collection. Fresh blood smears were prepared immediately after blood collection.

Auto Haematology Analyzer (Infitex) was used to do a haematological analysis on the blood samples which are positive and suspected for Cryptosporidium infection along with healthy animals as a control. The evaluation of haematological abnormalities regarding lymphocytes, neutrophils, eosinophils, Red Blood Cells (RBC), White Blood Cells (WBC), Haemoglobin (Hb) and total leucocyte count have been undertaken.

## Results

The hematological findings for the *Cryptosporidium* infected calves and the control group are presented in Table: 1. The results indicated that reduction in the total RBC count in the diseased calf group compared to the control group. Additionally, there was a notable decrease in the average hemoglobin (Hb) levels in the diseased calves. The mean packed cell volume (PCV) and mean corpuscular volume (MCV) values were significantly higher in the diseased group compared to the control group, while the mean corpuscular hemoglobin (MCH) was lower in the diseased group. Furthermore, the total leukocyte count (TLC) was comparatively elevated in the *Cryptosporidium*-infected calves. The mean percentage of neutrophils, eosinophils, and monocytes was also significantly higher in the diseased group than in the control group. while the mean lymphocyte count was significantly lower.

**Table 1:** The hematological findings for the *Cryptosporidium* infected calves and the control group are presented

| Parameters | Cattle calves | |
|---|---|---|
| | Obtained values ( N= 15) | Normal values (N= 15) |
| Haemoglobin (gm/dL) | 5.65±0.15 | 12.05±0.09 |
| RBC (×10⁶/µl) | 3.60+0.06 | 9.17±0.04 |
| Total leucocyte count (×10³/µl) | 25.07±1.91 | 6.11±0.09 |
| PCV (%) | 17.93±0.31 | 36.88±0.31 |
| Lymphocytes (%) | 67.10±0.64 | 64.67±0.37 |
| Neutrophils (%) | 41.63±0.18 | 37.50±0.35 |
| Monocytes (%) | 4.82±0.1 | 4.66±0.08 |
| Eosinophils (%) | 4.19±0.15 | 3.05±0.08 |
| Basophils %) | 0.78±0.05 | 0.57±0.02 |

## Discussion

In the current study, *Cryptosporidium*-infected calves exhibited significantly lower total RBC count, hemoglobin (Hb), and mean corpuscular hemoglobin (MCH) levels, along with markedly higher packed cell volume (PCV) and mean corpuscular volume (MCV) compared to the healthy calves. These findings are consistent with those of Mullakaev *et al.* (2020) [5], who observed significantly reduced Hb and RBC counts in diarrheic buffalo calves compared to healthy counterparts. Additionally, Saleh *et al.* (2022) [9] reported higher PCV values in diarrheal calves than in healthy controls. These alterations may be attributed to hemoconcentration, which occurs as a result of significant fluid loss from diarrhea, combined with inadequate milk and fluid intake.

The present findings also revealed that elevated total leukocyte count (TLC), along with higher percentages of neutrophils, eosinophils, and monocytes, and a reduced percentage of lymphocytes in the infected calves compared to non-infected ones. Similar results were reported by Brar *et al*. (2017) [1], who found notable leukocytosis, neutrophilia, and lymphopenia in diarrheal calves compared to healthy controls. Gamsjager *et al.* (2023) [2] suggested that *C. parvum* infection leads to neutrophilic enterocolitis, likely due to the incomplete development of innate immune defenses in neonatal calves. Likewise, eosinophilia was observed in *Cryptosporidium* infected calves, as noted by Sahu and Maiti (2011) [7]. These changes could be a result of the body's normal defense mechanisms against infection, dehydration, hemoconcentration, and the enteritis induced by *Cryptosporidium* in neonatal calves.

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