METABOLIC PROFILE OF 'DOWNER COW' SYNDROME

By

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THESIS

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requirements for the degree

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To my loving parents and
beloved late brother Avi

DECLARATION

I hereby declare that this thesis entitled "Metabolic Profile of 'Downer Cow' Syndrome" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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CERTIFICATE

Certified that the thesis, entitled "Metabolic Profile of **'Downer Cow' Syndrome**" is a record of research work done independently by **Miss** Mhachuvino **Catherine Khatsu**, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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MHACHUVINO CATHERINE KHATSU

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INTRODUCTION

'Downer Cow' Syndrome is a clinical condition of world-wide occurrence and importance. Clinically it is dealt as a complication of hypocalcaemia in dairy cattle. The term 'Downer Cow' (synonym: 'Creeper Cow') is used to describe dairy cows that vary from alert and normal but unable to get up. Hallgren (1955) and Hemsley (1957) regarded 'Downers' as cows that are normal in every respect but without the necessary muscular strength to regain feet. Cows that had parturient paresis are considered as 'Downers' when they do not get up within 24 to 48 hours after the initial treatment for milk fever. Cox et al. (1986) defined 'Downer Cow' as one down for at least 24 hours without apparent reason for being recumbent.

'Downer Cow' Syndrome may occur independently or follow apparent recovery after treatment for parturient paresis for the continued recumbency which in effect constitutes the disease. Typical 'Downer Cow' is bright and alert with reduced appetite and continues to eat and drink moderately. There are no systemic disturbances apparent among the affected animal (Blood et al., 1989).

A high incidence of 'Downer Cow' Syndrome among the crossbred dairy cattle in Kerala is increasingly observed in the recent past. Economic loss on account of loss of production, incapacitation of the animals and the high cost for prolonged treatment which often fails to evoke a positive response, noted to be substantial. Lack of proper line of treatment and control regimen based on the proper understanding of the etio-pathogenesis warrant detailed investigation of this condition. The present work was taken up to study the metabolic profile of 'Downer Cow' Syndrome in cattle to throw more light on its etio-pathogenesis.

The investigations were carried out on the following lines. The following parameters were selected as the main items of observation:

1. Haematological changes

   (i) Erythrocyte sedimentation rate

   (ii) Packed-cell volume

   (iii) Haemoglobin

   (iv) Red blood cell

   (v) White blood cell

   (vi) Differential leukocytic count

2. Biochemical changes

(i)	Calcium	(v)	Blood urea nitrogen
(ii)	Phosphorus	(vi)	Total serum protein, Albumin and Albumin/ Globulin Ratio
(iii)	Magnesium	(vii)	Plasma sodium
(iv)	Glucose	(viii)	Plasma potassium

3. Urinalysis for pathological constituents

(i)	Protein	(iv)	Blood
(ii)	Glucose	(v)	Bile pigments
(iii)	Ketone bodies	(vi)	Bile salts

Review of Literature

REVIEW OF LITERATURE

2.1 Incidence

'Downer Cow' Syndrome as a complication of parturient paresis in dairy cattle is reported from world over. The condition was reported from countries like, U.K. (Lewis, 1955; Boyd et al., 1964; Allen Davies, 1981 and Bindsiel, 1987), Sweden (Hallgren, 1955), Canada (Curtis et al., 1970), Denmark (Flagstad et al., 1970), USA (Rosenberger, 1958; Johnson, 1967; Gianturco, 1967; Julien et al., 1977; Erb and Grohn, 1988 and Cox and Marion, 1992), Australia (Warnock et al., 1978; Fenwick, 1969, 1977, 1986 and Blood and Radostits, 1989), India (Narayana et al., 1977; Prasad, 1988 and 1989 and Rao et al., 1991) and France (Barlet and Davicco, 1992).

Extensive data on the rate of incidence of this condition is not available in the literature consulted. However, in a Winconsin study Johnson (1965) recorded more than 30 cases of creeper type of 'Downer Cows'.

Thirty-four out of 400 cases of milk fever (17.8%) have been observed as 'Downers' by Fenwick (1969b).

Out of 191 milk fever episodes the number of 'Downers' were negligible when recumbent for less than six hours, but

the rate was 26 per cent when they were recumbent for 7-12 hours and not responding to treatment. The incidence rate increased to 32 per cent in animals recumbent for 12-18 hours (Fenwick, 1969).

Among the milk fever cases studied by Bjorsell et al. (1969), Fenwick (1969) and Curtis et al. (1970) the incidence rate of 'Downers' ranged from 4 per cent to 35 per cent.

In a feeding trial, animals maintained on an intake of 15 per cent crude protein 69.2 per cent of their diseases were metabolic disturbances including eight 'Downer Cows' six of which died during treatment. Groups of animals maintained on an intake of 8 per cent crude protein the incidence of metabolic disturbance was 7-14 per cent and there was no cases of 'Downer Cows' (Julien et al., 1977).

Narayana (1977) recorded 20 cases of 'Downer Cows' among crossbred cattle treated at the Veterinary College Hospital, Bangalore.

Fourteen out of 149 culled dairy cows after arrival at the abattoir became 'Downers' (Warnock et al., 1978).

Cox et al. (1982) induced experimental 'Downer Cow' Syndrome in eight animals using halothane anaesthesia.

In Wisconsin (USA) slaughter-house records indicated an annual loss in excess of 10,000 'Downer Cows' out of a population of about 1.8 million dairy cattle (Cox, 1982).

In a mail survey of 723 Mennisota dairy herds of 34,650 cow/year at risk an incidence rate of 21.4/1000 was reported by Cox et al. (1986).

Out of 584 cases of milk fever 1.9 per cent of non-alert 'Downer Cow' Syndrome was reported by Fenwick (1986).

While investigating on the problems of 'Downer Cow' Syndrome Prasad et al. (1988) reported the incidence of 16 cases from Punjab.

Blood and Radostits (1989) observed that though the incidence was high among heavy producers of great value accurate figures were not available due to variations in the nomenclature and accuracy in diagnosis of 'Downer Cow' Syndrome.

2.1.1 Breed

Rosenberger (1958) and Johnson (1963) observed that it is an all too frequent condition met with in general practice. The incidence was higher in dairy breeds than in beef cattle.

Narayana et al. (1977) observed that the condition was higher in Jersey-cross followed by Holstein-Friesian and Red-Dane crossbred.

Cox et al. (1986) identified a possible lower risk in Brown-Swiss than in Holstein cows (15.7/1000 cow-yr versus 22.2/1000 cow-yr) but the rates among Jersey and Guernseys were intermediate and the differences were not significant.

2.1.2 Age

'Downer Cow' Syndrome was observed in every stage of lactation and gestation, mostly as a sequelae to milk fever but it could occur at any time of the year and among the dairy cattle of any age (Rosenberger, 1958).

Johnson (1962) found that high producing cows which have had at least three calvings were more prone to suffer from this condition.

Johnson (1963) observed that cows late in lactation or even dry go down as 'Creeper Cows' and this condition followed first and second calvings but frequently seen in older cattle.

Narayana et al. (1977) reported that cows between 4-8 years of age were mostly affected.

Warnock et al. (1978) observed that culled dairy cattle go down as 'Downer Cows' during starvation period to slaughter.

Maxwell (1986) reported that most of the affected 'Downer Cows' are usually old and poorly fed.

Prasad et al. (1989) reported the incidence of 'Downer Cow' Syndrome among seven female buffaloes aged 4-8 years.

Prasanna et al. (1992) reported a case of 'Downer Cow' Syndrome in a crossbred cow of 8 years old.

2.1.3 Season

'Downer Cow' Syndrome was reported to be more prevalent in winter and early spring (Rosenberger, 1958).

Johnson (1962, 1963 and 1967) reported that alert 'Downer Cow' Syndrome was observed frequently during late winter and spring.

In Canada the incidence of 85 per cent cases of 'Downer Cow' Syndrome corresponded to the normal stabling time of dairy cattle and 70 out of 82 cases reported from November to April (Curtis et al., 1970).

Cox et al. (1986) observed that the incidence of this condition was significantly increased during the winter (December to February) and was correspondingly decreased during the spring (April to June).

2.2 Classification

Based on the clinical symptoms 'Downer Cow' Syndrome was classified into alert and non-alert 'Downer Cow' Syndrome (Fenwick, 1977 and 1986).

Cox (1982) categorised the 'Downer Cow' Syndrome into sternally recumbent and laterally recumbent cows.

Blood and Radostits (1989) classified 'Downer Cows' into alert Downer/Creeper cow and non-alert 'Downers' based on their clinical signs and symptoms.

2.3 Etiology

Hallgren (1955) considered 'Downer Cow' Syndrome as a special form of milk fever often associated with low serum phosphorus level.

Low serum phosphorus level was observed in 'Downer Cow' Syndrome as reported by Lewis (1955); Jonsson and Pehrson (1969); Kronfeld (1976); Allen and Davies (1981); Saulter (1986) Andrews (1986) Blood and Radostits (1989) and Fenwick and Daniel (1992a).

Rosenberger (1958) reported that the 'Downer Cow' Syndrome could occur as a sequalae to milk fever with protein deficiency as a major contributing factor.

Hypokalaemia was observed as an important factor in the development of 'Downer Cow' Syndrome (Johnson, 1962 and 1965; Jonsson and Pehrson, 1969; Fenwick, 1969b and Fenwick and Daniel, 1992a; Kronfeld, 1974 and 1976 and Andrews, 1986).

Fenwick (1969) reported that virtually all cases of 'Downer Cow' Syndrome occurred secondarily to milk fever and listed other disorders like limb dysfunction, hypothermia, hypocalcaemia and internal haemorrhage.

Curtis et al. (1970) stated that damage to the branches of sciatic nerve particularly the peroneal nerve could be a common cause for 'Downer Cow' Syndrome.

Kronfeld (1974) proposed that many cases of 'Downer Cow' Syndrome were complications of parturient paresis (hyperphosphataemia, hypokalemia and hyperglycaemia) that became exaggerated despite calcium therapy warranting independent specific therapy.

Narayana et al. (1977) stated that mechanical fracture, infection and metabolic disorders contributed to the etiology of 'Downer Cow' Syndrome.

Warnock et al. (1978) reported that 'Downer Cows' had significantly lower serum calcium level.

Hypocalcaemia, hypophosphataemia, deficiency of vitamin E and selenium, obesity, recumbency due to trauma, undernutrition and autointoxication from high protein intake were suggested as causes of 'Downer Cow' Dyndrome by Allen and Davies (1981).

Cox (1982) hypothesized that many primary factors including parturient paresis could be the cause for initial stage of recumbency followed by secondary muscle and nerve damage due to tissue compression.

Andrews (1986) stated that 'Downer Cow' Syndrome is caused primarily by milk fever followed by secondary ischemic necrosis of muscles and nerves due to pressure damage. Secondary damages may result in permanent recumbency even after the primary cause was eliminated on treatment.

Fenwick et al. (1986) reported low plasma potassium as possible cause of 'Downer Cow' Syndrome.

Bindseil (1987) reported that some of the 'Downer Cow' Syndrome are complication of rupture of necrotic musculature.

Prasad et al. (1988) reported increased serum creatine phosphokinase (CPK) level as a result of ischaemic muscle damage and necessary cell membrane permeability.

Rao et al. (1991) suspected 'Downer Cow' Syndrome as the outcome of hypocalcaemia and/hypomagnesemia.

Prasanna et al. (1992) proposed various etiological agents such as milk fever not responding to calcium therapy, hypophosphataemia, hypokalaemia, fat cow syndrome, vitamin E and selenium deficiencies, excessive protein intake and trauma to the sciatic and/or obturator nerves at the time of parturition.

Barlet and Davicco (1992) reported hypophosphataemia as an etiological factor of 'Downer Cow' Syndrome.

2.4 Clinical signs

Rosenberger (1958) reported that a typical 'Downer Cow' in sternal recumbency was generally bright and alert with good sensitivity over the entire body and legs and was passing dung and urine normally. The heart and lung activity and body temperature were within normal physiological limits as were the appetite and rumination.

Johnson (1963) reported that 'Creeper Cow' Syndrome exhibited weakness of hindquarters, a characteristic flexed fetlock and struggling mostly with the forequarter efforts. The affected cow held the head high with ears up and wagging and shoulders erect. Due to weakness the hindlegs were

extended under the belly along the sides or backwards away from its body. 'Creeper Cow' rested on one hip and leg or flat on its belly and udder. Some rolled over on their side but could regain sternal posture when assisted. Rectal temperature was between 100 and 101°F. The animal continued to eat hay with appetite, rumination, micturition and defecation suppressed, though not as severe as in the case of milk fever. Anxious, nervous and evasive signs were observed and pupil was more responsive than in milk fever but less reactive than a normal cow. Muzzle secretions were reduced.

Curtis et al. (1970) reported that most of the 'Downer Cows' responded clinically to calcium therapy except that it remained recumbent. The affected cows were bright and alert with normal pupillary light reflex, fair appetite, rumination, defecation and micturition. the 'Downer Cows' often exhibit a frog-sitting posture, some with the legs under them but were unable to extend the hocks or fetlock and crawled about.

Allen and Davies (1981) observed that 'Downer Cows' were usually bright and continued to ruminate in the absence of other disorders. Attempts for getting up were often half-hearted. When strongly stimulated extension of the neck to the ground with open mouth protruding the tongue and groaning about and inability to get up were also noticed. The affected

cows made strenuous but usually futile effort to get up and stand and crawled around with knuckling of fetlock.

Cox et al. (1982) reported that experimentally induced 'Downer Cows' exhibited rigid and swollen right-pelvic limb and dog-sitting posture and flexion of fetlock joints were the other signs.

Andrews (1986) stated that typical 'Downer Cows' were bright and alert and had relatively normal appetite with no clinical abnormalities other than increased pulse rate. If made to rise the front legs could bear weight but showed hindquarter weakness.

Fenwick et al. (1986) reported that all non-alert 'Downer Cows' became laterally recumbent some with expiratory moan and passed mucoid faeces which in many cases contained spots of blood.

Cox and Marion (1992) reported that the affected 'Downer Cow' remained in sternal recumbency with the left hindlimb tucked under the body. When they could stand up the fetlock of the right hind-limb was seen eventually flexed.

2.5 Observations on blood - Normal

2.5.1 Haematological

2.5.1.1 Erythrocyte Sedimentation Rate (ESR)

Erythrocyte sedimentation rate in healthy cattle determined by Culter method ranged from 2.4 mm/7 hours (Ferguson, 1937).

Bunce (1954) reported that the normal erythrocyte sedimentation rate value in healthy cattle ranged from 2.25 to 4.0 mm/24 hours.

Greatorex (1957) reported that the ESR of calf and adult dairy cattle ranged between 1.00 and 8.00 mm/24 hours with a mean value of 3.0 $\pm$ 1.0 mm/24 hours.

Sippel (1958) stated that the ESR in cattle was variable and that a normal value could not be given.

Mithuji et al. (1966) and Schalm (1975) have reported that the mean value of ESR in healthy cattle was 0.00 mm/hour. In healthy Australian Jersey and crossbred (Jersey x Sindhi) cows identical ESR values were reported by Aleyas and Alikutty (1973).

Sreekumar and Thomas (1990) reported that the ESR in healthy Jersey and Red Sindhi crossbred and indigenous

Kangayam bullocks were 0.58 ± 0.02 and 0.50 ± 0.02 mm per 24 hours, respectively.

2.5.1.2 Packed cell volume (PCV)

Greatorex (1957) reported that the mean haematocrit value of adult dairy cattle was 37.44 ± 4.0 mm and its range varied from 21.0 to 53.0 mm.

Aleyas and Alikutty (1973) observed that the mean values of PCV in healthy Australian Jersey and crossbred (Jersey x Sindhi) cows were 36.00 and 28.58 per cent, respectively.

Rao et al. (1981) stated that the mean haematocrit level in Ongole cows with normal oestrous cycle was 28.94 ± 0.93 per cent.

Deshpande and Sawant (1986) reported that the mean values of PCV in pregnant and lactating, pregnant and non-lactating, non-pregnant and lactating and non-pregnant and non-lactating Red Kandhari cows were 32.25 ± 1.82, 35.38 ± 0.84, 30.94 ± 0.81 and 34.86 ± 1.05 per cent, respectively.

Prasad et al. (1987) reported that the mean value of PCV in clinically normal crossbred dairy cows of five to eight

years of age in advanced pregnancy and early lactation were 29.71 ± 1.60 and 30.71 ± 0.81 per cent, respectively.

The mean value of PCV in healthy cows in heat was 27.00 ± 1.90 per cent (Parmar and Mehta, 1989).

Sreekumar and Thomas (1990) reported that the mean PCV level in Kangayam and crossbred (Jersey x Red Sindhi) bullocks in hot humid tropics were 32.10 ± 0.28 and 35.45 ± 0.28 per cent, respectively.

Salim and Joshi (1992) stated that the mean value of PCV in apparently healthy cattle aged one to six years was 30.75 ± 4.68 per cent.

2.5.1.3 Haemoglobin (Hb)

Greatorex (1957) recorded that the mean haemoglobin value in adult dairy cattle was 12.0 ± 1.5 g/100 ml.

Wingfield and Tumbleson (1972) observed that the mean Hb content in Guernsey and Holstein-Friesian cows was 11.5 ± 0.10 g/100 ml.

Aleyas and Alikutty (1973) reported that the mean Hb values in healthy Australian Jersey and crossbred (Jersey x Sindhi) cows were 10.26 and 9.10 g per cent, respectively.

According to Schalm (1975) the mean Hb value in normal cattle ranged from 8.0 to 15.0 g/dl with a mean value of 11.0 g/dl.

Payne and Maitra (1981) observed that the mean Hb level in apparently healthy lactating Haryana and Sahiwal cattle were 10.15 ± 0.68 and 10.05 ± 0.54 g per cent, respectively.

Deshpande and Sawant (1986) reported that the mean Hb value in pregnant and lactating, pregnant and non-lactating, non-pregnant and lactating and non-pregnant and non-lactating Red Kandhari cows were 11.65 ± 0.32, 11.79 ± 0.32, 10.99 ± 0.29 and 11.71 ± 0.26 g per cent, respectively.

Haider and Siddiqui (1989) reported that the mean Hb value in healthy dairy cows during summer and winter seasons were 12.0 and 10.8 g/100 ml, respectively.

Parmar and Mehta (1989) observed that the mean Hb content of blood in healthy cows in heat was 10.60 ± 0.34 g per cent.

According to Sreekumar and Thomas (1990) the mean Hb level in indigenous Kangayam and crossbred (Jersey x Red Sindhi) bullocks were 12.16 ± 0.15 and 11.76 ± 0.14 g/100 ml, respectively.

Gujar et al. (1990) reported that the mean value of Hb level in Kankrej heifers was 11.32 ± 0.21 g per cent.

2.5.1.4 Red blood cell (RBC)

The normal range of erythrocytic count in adult dairy cattle varied from 4.1 to 7.0 million per cmm and the mean value was 5.7 ± 1.3 million per cmm (Greatorex, 1957).

Aleyas and Alikutty (1973) reported that the mean values of RBC in healthy Australian Jersey and crossbred (Jersey x Sindhi) cows were 5.33 and 5.19 million/cmm, respectively.

According to Payne and Maitra (1981) the mean values of RBC in healthy lactating Haryana and Sahiwal cows were 6.85 ± 0.86 and 6.79 ± 0.62 million/cmm, respectively.

Despande et al. (1986) reported that the mean values of total erythrocytic count in healthy red Kandhari cows during pregnant and lactating, pregnant and non-lactating, non-pregnant and lactating and non-pregnant and non-lactating stages were 4.51 ± 0.41, 3.94 ± 0.22, 3.59 ± 0.31 and 3.97 ± 0.25 million/cmm, respectively.

2.5.1.5 White blood cell (WBC)

Normal total leukocyte count in adult dairy cattle was found to be 9.1 ± 1.4 thousand/cmm (Greatorex, 1957).

According to Aleyas and Alikutty (1973) the normal mean WBC count in healthy Australian Jersey and crossbred (Jersey x Sindhi) cows were 7479 and 7963 no/cmm, respectively.

'ayne and Maitra (1981) found that the mean values of WBC in apparently healthy lactating Haryana and Sahiwal cows were 7.96 ± 0.43 and 7.82 ± 0.76 thousand/cmm. respectively.

Despande et al. (1987) reported that the mean total leukocytic count in healthy Red Kandhari cows during pregnant and lactating, pregnant and non-lactating, non-pregnant and lactating and non-pregnant and non-lactating states were 8.18 ± 0.92, 10.33 ± 0.63, 7.41 ± 0.28 and 9.29 ± 0.52 thousand/cmm, respectively.

The mean total leukocytic count in clinically normal crossbred dairy cows, aged five to eight years and in advanced stage of pregnancy and lactation were 5.13 ± 0.31 x 10^6/ml and 4.18 ± 0.42 x 10^6/ml, respectively (Prasad et al., 1987).

Haider and Siddiqui (1989) reported that the mean

leukocytic count in healthy dairy cows during summer and winter seasons were 8,900 and 7,200/cmm, respectively.

Salim and Joshi (1992) reported that the mean total leukocytic count in apparently healthy cows was 6.88 ± 1.35 x $10^3/\mu L$.

2.5.1.6 Differential leukocyte count (DLC)

Greatorex (1957) reported that the normal values of lymphocytes, neutrophils, monocytes, eosinophils and basophils in adult dairy cattle ranged from 36-72, 15-45, 0-8, 2-30 and 0-0 per cent, respectively.

Mithuji et al. (1966) reported that the mean values of lymphocytes, neutrophils, monocytes, eosinophils and basophils in healthy cattle were 67 ± 0.9, 23 ± 0.7, 4 ± 0.2, 6 ± 0.4 and 0.0 per cent, respectively.

Aleyas and Alikutty (1973) reported that the mean values of lymphocytes, neutrophils, eosinophils, monocytes and basophils in healthy Australian Jersey and crossbred (Jersey x Sindhi) cows were 66.91, 17.25, 13.58, 2.08, 0.17 and 59.66, 28.91, 9.00, 2.25 and 0.16 per cent, respectively.

Payne and Maitra (1981) reported that the mean values of neutrophils, lymphocytes, monocytes, eosinophils and basophils in apparently healthy lactating Haryana and Sahiwal

cows were 27.61 ± 0.73 and 26.25 ± 0.92, 64.15 ± 0.14 and 63.35 ± 0.11, 3.05 ± 0.12 and 3.45 ± 0.18, 4.75 ± 0.06 and 6.33 ± 0.03 and 0.45 ± 0.11 and 0.62 ± 0.06 per cent, respectively.

Deshpande et al. (1986) reported that the mean values of lymphocytes, neutrophils, eosinophils, monocytes and basophils in Red Kandhari cows were 64.33 ± 1.91, 22.50 ± 3.17, 11.83 ± 3.24, 4.00 ± 3.00 and 0.00 per cent when pregnant and lactating, 63.83 ± 2.12, 24.87 ± 2.26, 10.35 ± 1.12, 2.00 ± 0.45 and 0.00 per cent when pregnant and non-lactating, 57.16 ± 2.72, 31.12 ± 2.56, 10.71 ± 1.10, 1.88 ± 0.24 and 1.00 ± 0.00 per cent when non-pregnant and lactating and 59.57 ± 2.12, 25.27 ± 2.36, 13.67 ± 1.04, 2.00 ± 0.29 and 1.00 ± 0.00 per cent when non-pregnant and non lactating states.

Prasad et al. (1987) reported that the mean values of neutrophils, lymphocytes, eosinophils, monocytes and basophils in clinically normal crossbred dairy cows aged 5 to 8 years were respectively 23.71 ± 3.77, 66.42 ± 2.36, 4.85 ± 1.34, 3.30 ± 0.88 and 1.25 ± 0.65 per cent during advanced pregnancy and 23.71 ± 3.58, 62.71 ± 3.98, 11.14 ± 1.24, 2.43 ± 0.61 and 0.28 ± 0.18 per cent during e arly lactating stage.

Salim and Joshi (1992) observed that the mean DLC values in apparently healthy cows were 63.68 ± 6.43 per cent lymphocytes, 31.47 ± 5.47 per cent neutrophils, 3.50 ± 2.42 per cent monocytes and 1.31 ± 1.13 per cent eosinophils.

2.5.2 Biochemical

2.5.2.1 Glucose

Payne et al. (1970) reported that the mean blood glucose concentration among dairy animals varied from herd to herd and it ranged from 36.7 to 54.1 mg/100 ml with a mean value of 45.4 mg/100 ml.

Normal value of glucose in whole blood of healthy cattle was reported as 35 to 55 mg/dl (Benjamin, 1978).

Lee et al. (1978) reported that the mean serum glucose level in lactating and dry cows were 66.07 ± 9.72 and 70.48 ± 8.49 mg/100 ml, respectively.

Kaneko (1980) recorded the blood glucose concentration in healthy adult cow as 45 to 75 mg/dl (57 ± 7 mg/dl).

Wiener and Russell (1980) reported that the mean plasma glucose level in healthy Ayrshire female cattle aged six months to six years was 53 ± 0.6 mg/l.

Peterson and Waldern (1981) recorded the mean blood glucose level of 65.6 ± 0.9 mg/100 ml in purebred Holstein-Friesian cattle of 2 to 12.5 years of age.

Mulei and Daniel (1989) recorded the mean plasma glucose concentration of 3.11 ± 0.03 and 3.09 ± 0.03 mmol/L and 2.95 ± 0.04 and 3.00 ± 0.04 mmol/L in two dairy herds during the pre- and postpartum stages, respectively.

2.5.2.2 Blood urea nitrogen (BUN)

Payne et al. (1970) recorded the serum urea nitrogen level ranging from 9.5 to 20.5 mg/100 ml with the mean value of 14.9 mg/100 ml in healthy dairy cattle.

Tumbleson et al. (1972) observed that there were no differences in mean serum urea nitrogen concentration between female Holstein-Friesian and Guernsey aged 3.5 to 4.5 years and above 10.5 years and the respective mean values were 16.8 ± 0.6 and 17.9 ± 0.6 mg/100 ml and 18.2 ± 1.5 and 15.5 ± 0.7 mg/100 ml, respectively.

Payne et al. (1974) reported that the mean value of serum urea nitrogen in cattle was 12.3 mg/100 ml during winter and 17.8 mg/100 ml during the summer seasons.

Normal value of blood urea nitrogen in cattle ranged from 10-30 mg/dl (Benjamin, 1985).

Kaneko (1980) reported that the normal value of serum urea nitrogen in domestic animals in general ranged from 10-30 mg/dl.

Peterson and Waldern (1981) reported that the mean serum urea nitrogen level in Holstein-Friesian cow was 16.1 ± 0.4 mg/100 ml.

Mulei and Daniel (1989) reported the mean plasma urea nitrogen level during the pre and postpartum stages in two dairy herds respectively as 4.98 ± 0.40 and 3.34 ± 0.30 mmol/L and 3.27 ± 0.40 and 3.41 ± 0.40 m mol/L.

2.5.2 3 Calcium

The normal serum calcium level in cattle ranged between 8.0 to 12.0 mg per 100 ml out of which 3.6 to 7.7 mg per 100 ml existed in the diffusible ionised form and the remaining in non-diffusible protein bound form (Moodie, 1960).

Mylrea and Bayfield (1968) reported the serum calcium concentration in apparently healthy dairy cattle as 10.2 ± 0.56 mg/ml.

Payne et al. (1970) recorded the mean value of serum calcium concentration as 9.27 mg/100 ml ranging from 8.3 to 10.2 mg/100 ml in dairy cattle.

Tumbleson et al. (1972) reported the mean value of serum calcium level in female Holstein-Friesian and Guernsey ranging from 3.5 to 4.5 and above 10.5 years of age as 10.64 ± 0.08 and 11.15 ± 0.11 mg/100 ml and 10.60 ± 0.14 and 10.72 ± 0.10 mg/100 ml, respectively.

Payne et al. (1974) reported the mean values of serum calcium level in dairy cow as 9.5 mg/100 ml during winter and 9.6 mg/100 ml during the summer seasons.

Lee et al. (1978) reported the mean serum calcium level in lactating and dry cows as 9.57 ± 0.99 and 9.93 ± 0.93 mg/100 ml, respectively.

Larson et al. (1980) recorded the mean serum calcium level in the postpartum dairy cow as 8.24 ± 0.24 mg/100 ml.

Kaneko (1980) stated that the normal serum calcium concentration in normal adult animal averaged 10 mg/dl and ranged from 9.0 to 12.0 mg/dl.

Peterson and Waldern (1981) reported that the mean serum calcium level in Holstein-Friesian cow was 9.59 ± 0.08 mg/100 ml.

According to Benjamin (1985) the normal serum calcium level in cattle varied from 4.7 to 6.1 mEq/L.

Sivaiah et al. (1986) reported that the serum calcium levels in Ongole crossbred cows were 8.15 ± 2.46 during oestrum, 7.22 ± 1.62 nearing parturition, 7.48 ± 2.13 during anoestus, 7.24 ± 1.77 among recent calvers and 7.04 ± 2.07 mg per cent during early pregnancy.

The mean serum calcium level in two dairy herds during pre- and postpartum stages were 2.46 ± 0.06 and 2.43 ± 0.06 mmol/L and 2.26 ± 0.04 and 2.34 ± 0.04 mmol/L, respectively (Mulei and Daniel, 1989).

2.5.2.4 Inorganic phosphorus

Mylrea and Bayfeld (1968) found that the inorganic phosphorus levels in the blood and serum were 4.7 ± 0.7 and 6.2 ± 1.1 mg/100 ml and 4.0 ± 1.0 and 5.5 ± 1.4 mg/100 ml, in apparently healthy dairy heifers and in healthy cows, respectively.

Payne et al. (1970) reported that the mean serum inorganic phosphorus level in dairy cattle was 5.42 mg/100 ml and its range varied from 3.6 to 7.2 mg/100 ml.

Tumbleson et al. (1972) reported that the serum inorganic phosphorus level decreased with increasing age and the mean values in female Holstein-Friesian and Guernsey cows aged 3.5 to 4.5 years and above 10.5 years were 6.00 ± 0.16

and 5.55 ± 0.24 mg/100 ml and 5.70 ± 0.74 and 5.35 ± 0.45 mg/100 ml, respectively.

Payne et al. (1974) reported that the mean serum inorganic phosphorus levels in dairy cows during the winter and summer seasons were 5.9 and 5.8 mg/100 ml, respectively.

Lee et al. (1978) reported that the mean serum inorganic phosphorus levels among lactating and dry dairy cows were 5.65 ± 1.37 and 5.78 ± 1.05 mg/100 ml, respectively.

Kaneko (1980) observed that the serum inorganic phosphorus level in normal adult cattle varied from 4.0 to 7.0 mg/dl (1.3 to 2.3 m mol/L).

Larson et al. (1980) reported that the mean serum inorganic phosphorus levels in dairy cows 14 to 21 and 38 to 45 days post-partum were 8.29 ± 0.31 and 7.28 ± 0.27 mg/100 ml, respectively.

Peterson and Waldern (1981) observed that the mean serum inorganic phosphorus levels of 5.59 ± 0.06 mg/100 ml in normal Holstein-Friesian cattle was found to be 5.01 ± 0.11, 5.55 ± 0.10 and 6.20 ± 0.28 mg/100 ml in lactating non-pregnant lactating pregnant and dry animals, respectively.

Rao et al. (1981) recorded the mean value of inorganic phosphorus in normal Ongole cows as 6.11 ± 0.39 mg %.

Sivaiah et al. (1986) observed that the serum inorganic phosphorus values among Ongole crossbred cows during the periods of oestrus, nearing parturition, anoestrum, recent calver and early pregnancy were 6.36 ± 1.50, 5.73 ± 0.92, 6.21 ± 1.24, 7.18 ± 0.90 and 6.22 ± 1.97 mg per cent, respectively.

Prasad et al. (1987) reported that the mean serum inorganic phosphorus level in normal crossbred dairy cows aged five to eight years during advanced pregnancy and early lactation, were 6.50 ± 0.41 and 5.47 ± 0.27 mg/dl, respectively.

Mulei and Daniel (1989) reported that the mean serum inorganic phosphorus levels in two dairy herds of Holstein-Friesian and Jersey cows during the pre- and post-partum periods were 2.24 ± 0.05 and 2.01 ± 0.04 m mol/L and 2.07 ± 0.06 and 1.97 ± 0.05 m mol/L, respectively.

Kumar and Sharma (1991) reported that the mean value of serum inorganic phosphorus in healthy fertile rural cows was 6.44 ± 0.42 mg/dl.

Salim and Joshi (1992) recorded the mean serum inorganic phosphorus level in apparently healthy cows aged one to six years as 5.79 ± 0.87 mg/dl.

2.5.2.5 Magnesium

Mylrea and Bayfield (1968) observed that the normal serum magnesium level in apparently healthy dairy cattle was 2.30 ± 0.36 mg/100 ml.

Payne et al. (1970) reported that the mean value of serum inorganic phosphorus in normal dairy cattle was 2.58 mg/100 ml which ranged from 2.0 to 3.1 mg/100 ml.

The normal serum magnesium levels in dairy cows during winter and summer seasons were found to be 2.4 and 2.6 mg/100 ml (Payne et al., 1974).

Lee et al. (1978) reported that the mean serum magnesium levels in lactating and dry cows were 2.17 ± 0.28 and 2.11 ± 0.22 mg/100 ml, respectively.

The mean serum magnesium level in dairy cows 14 to 21 and 38 to 45 days postpartum were 2.24 ± 0.08 and 2.23 ± 0.70 mg/100 ml, respectively (Larson et al., 1980).

Prasad et al. (1987) reported that the mean values of serum magnesium in normal crossbred cows aged five to eight years during advanced pregnancy and early lactating period were 4.80 ± 0.29 and 3.44 ± 0.18 mg/dl, respectively.

The mean serum magnesium levels in two dairy herds of Holstein-Friesian and Jersey during pre and post-partum stages were respectively 0.88 ± 0.02 and 0.92 ± 0.03 m mol/L and 0.91 ± 0.03 and 0.93 ± 0.02 m mol/L (Mulei and Daniel, 1989).

2.5.2.6 Total protein

Mylrea and Healy (1968) reported that the mean serum protein level in apparently healthy dairy heifers and cows were 6.90 ± 0.66 and 7.90 ± 0.64 g/100 ml with values ranging from 5.5 to 8.2 and 6.6 to 9.2 g/100 ml, respectively.

Payne et al. (1970) established that the mean value of total serum protein in healthy dairy cattle was 7.11 g/100 ml which ranged from 6.1 to 8.1 g/100 ml.

The mean serum total protein level in female Holstein-Friesian and Guernsey cattle aged 3.5 to 4.5 and above 10.5 years were 9.03 ± 0.07, 8.73 ± 0.12, 10.20 ± 0.35 and 10.11 ± 0.29 g/100 ml, respectively (Tumbleson et al., 1972).

Schalm et al. (1975) observed that the mean value of serum total protein in healthy cattle was 6.0 to 8.0 g/dl.

Lee et al. (1978) reported that the mean serum total protein among lactating and dry cows were 8.16 ± 0.81 and 8.09 ± 0.87 g/100 ml, respectively.

The mean serum total protein values among dairy cows during 14 to 21 and 38 to 45 days post-partum were 7.49 ± 0.07 and 7.91 ± 0.06 g/100 ml, respectively (Larson et al., 1980).

Peterson and Waldern (1981) observed that the mean serum total protein value in Holstein-Friesian cows was 8.24 ± 0.05 g/100 ml, and in lactating non-pregnant, lactating pregnant and dry cows were 7.73 ± 0.09, 7.76 ± 0.08 and 9.23 ± 0.23 g/100 ml, respectively.

Green et al. (1982) reported that the mean serum total protein in normal cattle aged six to eleven years was 7.71 g/dl and the range varied from 7.04 to 7.96 g/dl.

Singh and Choudhary (1988) reported that the mean total serum protein levels in Sahiwal and crossbred cattle during pre and post-partum week, 7th week of lactating and in non-lactating cows were 7.34 ± 0.22, 7.80 ± 0.30, 7.57 ± 0.17 and 6.94 ± 0.16 g/dl, respectively.

Gujar et al. (1990) reported that the mean value of serum protein in Kankrej heifers during fertile oestrus period was 7.57 ± 0.09 g per cent.

Kumar and Sharma (1991) reported that the mean value of total serum protein in healthy fertile rural cows was 8.45 ± 0.63 g/dl.

Gaikwad et al. (1992) recorded the mean value of serum protein in adult healthy crossbred (Jersey x Red Kandhari) cattle as 7.89 ± 0.20 g per cent.

2.5.2.7 Serum Albumin

Mylrea and Healy (1968) reported that the normal serum albumin value in apparently healthy dairy cows was 3.2 ± 0.43 g/100 ml.

According to Payne et al. (1970) the serum albumin level in apparently healthy dairy cow varied from 2.7 to 3.9 g/100 ml with a mean value of 3.31 g/100 ml.

Tumbleson et al. (1972) reported that the mean serum albumin level in female Holstein-Friesian and Guernsey cattle aged 3.5 to 4.3 and above 10.5 years were 4.06 ± 0.06, 4.17 ± 0.07 and 3.99 ± 0.26 and 3.72 ± 0.13 g/100 ml, respectively.

Payne et al. (1974) reported that the mean serum albumin level in healthy dairy cows during winter and summer seasons were 3.0 and 3.4 g/100 ml, respectively.

Lee et al. (1978) reported that the normal serum albumin value in healthy cows was 3.03 to 3.55 g/dl.

Kaneko (1980) reported that the normal serum albumin value in healthy cows was 3.03 to 3.55 g/dl.

Peterson and Waldern (1981) recorded that the mean serum albumin value in Holstein-Friesian cows was 4.00 ± 0.03 g/dl and the respective values for lactating non-pregnant, lactating pregnant and dry periods were 3.87 ± 0.06, 4.17 ± 0.06 and 3.97 ± 0.14 g/dl.

Normal serum albumin in healthy cows aged six to elevent years varied from 3.70 to 3.97 g/dl and the mean value was 3.82 g/dl (Green et al., 1982).

The normal serum albumin levels in Sahiwal and crossbred cattle during pre and post-partum, 7th week of lactating and non-lactating periods were 3.40 ± 0.07, 3.21 ± 0.08, 3.17 ± 0.06 and 3.25 ± 0.06 g/dl, respectively (Singh and Choudhary, 1988).

The normal range of serum albumin value of 2.1 to 3.6 g/dl in cattle was reported by Blood et al. (1989).

Gaikwad et al. (1992) reported that the mean serum albumin level in adult healthy crossbred (Jersey x Red Kandhari) cows was 5.53 ± 0.22 g per cent.

2.5.2.8 Albumin/Globulin Ratio (A/G Ratio)

Tashjian et al. (1968) reported that the mean albumin/globulin ratio was 0.76 in normal Aryshire cattle.

Tumbleson et al. (1972) observed that the mean A/G ratio in female Holstein-Friesian and guernsey cattle over four years was 0.76.

Kaneko (1980) reported that the normal A/G ratio in healthy cattle was between 0.84 to 0.94 and the mean value was 0.89 ± 0.05.

Green et al. (1982) reported that the cattle aged six to eleven years had an A/G ratio of 0.89 to 1.28.

Gaikwad et al. (1992) reported that the mean value of A/G ratio in adult healthy crossbred (Jersey x Red Kandhari) cows was 0.42 ± 0.02.

2.5.2.9 Sodium

The normal serum sodium in apparently healthy dairy cattle ranged from 131 to 152 mEq/L and the mean value was 141 ± 5.2 mEq/L (Mylrea and Bayfield, 1968).

According to Payne et al. (1970) the normal serum sodium level in dairy cow ranged from 135.00 to 143.10 mEq/L and the mean value was 139.00 mEq/L.

The normal serum sodium level in dairy cows during winter and summer seasons were 138.6 and 136.7 mEq/L, respectively (Payne et al., 1974).

Kaneko (1980) reported that the normal serum sodium level in cattle was 132 to 152 mEq/L.

Barua et al. (1988) recorded that the mean values of serum sodium in normal healthy cows on 0, 5, 10, 15 and 20 days of oestrous period were 139.13 ± 2.28, 143.13 ± 2.18, 141.63 ± 2.44, 139.88 ± 2.72 and 143.63 ± 1.89 mEq/L, respectively.

Mulei and Daniel (1989) reported that the plasma sodium levels in two herds of dairy cows during pre and postpartum periods were respectively 141.5 ± 1.21 and 141.8 ± 1.11, 140.1 ± 0.09 and 140.5 ± 1.01 m mol/L.

Salim and Joshi (1992) reported that the mean serum sodium level in apparently healthy cows was 142.68 ± 3.51 mEq/L.

2.5.2.10 Potassium

Mylrea and Bayfield (1968) reported that the normal serum potassium level in apparently healthy dairy cattle was 4.7 ± 0.48 and it ranged from 3.7 to 5.7 mEq/L.

Payne et al. (1970) reported that the serum potassium level in healthy dairy cow was 4.75 mEq/L and its range varied from 3.9 to 5.6 mEq/L.

According to Tumbleson et al. (1972) the mean serum potassium level in Holstein-Friesian and Guernsey cows aged 3.5 to 4.5 and above 10.5 years were 4.47 ± 0.08, 4.33 ± 0.10, 4.38 ± 0.12 and 4.40 ± 0.10 mEq/L, respectively.

Payne et al. (1974) reported that the normal serum potassium values during winter and summer seasons were 4.9 and 5.0 mEq/L, respectively.

Kaneko (1980), Benjamin (1985) and Blood and Radostits (1989) have observed that the mean serum potassium level in healthy cattle varied from 3.9 to 5.8 mEq/L.

Barua et al. (1988) reported that the mean serum potassium level in normal healthy cows on 0, 5, 10, 15 and 20 days of the oestrous period were 5.23 ± 0.54, 5.08 ± 0.43, 5.28 ± 0.47, 4.53 ± 0.43 and 5.48 ± 0.75 mEq/L, respectively.

Serum potassium levels in two dairy herds during pre and post-partum periods were found to be 4.59 ± 0.81 and 4.44 ± 0.04, 4.44 ± 0.04 and 4.38 ± 0.42 and 4.51 ± 0.04 m mol/L, respectively (Mulei and Daniel, 1989).

Salim and Joshi (1992) reported that the mean value of serum potassium in apparently healthy cows was 4.65 ± 0.47 mEq/L.

2.6 Observations on blood-diseased

2.6.1 Haematological (ESR, PCV, Hb, RBC, WBC and DLC)

Narayana et al. (1977) observed that the values of haemoglobin, red blood cells and white blood cells in four cases of 'Downers' in crossbred cows were 8.68 ± 0.24 g/100 ml, 5.9 ± 0.54m/cmm and 11,012 ± 1,051/cmm, respectively. The percentage of neutrophils, lymphocytes, monocytes, eosiphils and basophils were 44.0 ± 3.10, 48.0 ± 5.48, 4.5 ± 5.48, 4.5 ± 2.29, 3.5 ± 1.66 and 0.00, respectively.

Fenwick (1986) observed an increase in the packed-cell volume in non-alert 'Downer Cows'.

Pandey and Parai (1988) reported a significantly higher packed-cell volume (38.81 ± 0.59%) in 'Downer Cows' compared to healthy control animals.

Blood et al. (1989) stated that the haematological values in 'Downer cows' were usually comparable to those found in recently calved normal cows.

Slight elevations in Hb (10.77 ± 1.09 g %) PCV (40.08 ± 3.62 %) and erythrocyte count (7.75 ± 0.62 x 10^6m m^3) but little changes in the erythrocyte indices around the third hour of experimentally induced 'Downer cow' Syndrome were observed by Prasad et al. (1989). He also observed

significant increase in both total leukocyte and neutrophil counts and a decrease in lymphocyte count till the 24 hour period . The respective mean values of Hb, PCV, TEC and TLC at 48 hours were 9.58 ± 0.87 g %, 32.36 ± 3.76 %, 6.30 ± 0.45 x $10^6/mm^3$, 10.80 ± 0.73 x $10^3/mm^3$. The mean values for neutrophils, lymphocyte, monocyte, eosinophils and basophils were 35.20 ± 7.51, 63.40 ± 7.86, 0.40 ± 0.55, 1.00 ± 0.55 and 0.00 % at 48 hours, respectively.

2.6.2 Biochemical

2.6.2.1 Glucose

Blood and Radostits (1989) stated that there was no variation in blood glucose level in the affected 'Downer Cows'.

Prasad et al. (1989) reported that the blood glucose values in experimental 'Downer Cow' Syndrome were 60.93 ± 7.51, 90.88 ± 20.67, 94.41 ± 22.40, 79.52 ± 19.02, 56.74 ± 6.19 and 43.00 ± 6.19 mg % at 0, 3, 6, 9, 24 and 48 hours of the recumbency, respectively.

2.6.2.2 Blood Urea Nitrogen (BUN)

Julien et al. (1977) observed that the plasma urea nitrogen values in experimental alert 'Downers' were significantly less in group received 8 % crude protein (5.6

and 4.1 mg %) compared to the group received 15 % crude protein (13.1 and 14.8 mg %).

Andrews (1986) observed a fall in BUN level after three days of recovery from 'Downer Cow' Syndrome.

Prasad et al. (1989) could not observe any change in the BUN level in experimentally induced 'Downer Cow' Syndrome and the values obtained were 18.40 ± 1.63, 19.20 ± 2.05, 20.20 ± 1.77, 20.00 ± 2.00, 20.20 ± 1.28 and 18.00 ± 1.48 mg % at 0, 3, 6, 9, 24 and 48 hours, respectively.

2.6.2.3 Calcium

Curtis et al. (1970) opined that there was consistent hypocalcaemia during the initial stage of recumbency in 'Downer Cow' Syndrome and that serum calcium returned to normal level within 24 to 48 hours after treatment with calcium and phosphorus.

Roine et al. (1973) stated a significantly higher mean calcium value in alert sternally recumbent cow than in the somnolent sternally recumbent cows.

Fenwick (1977) claimed that hypocalcaemia prevailed in most of the cases of non-alert 'Downers'.

Narayana et al. (1977) observed normocalcaemia in 'Downer Cow' Syndrome and that the mean value of serum calcium level was 11.75 ± 0.83 mg/100 ml.

Julien et al. (1977) recorded no significant change in serum calcium level (10.9 and 10.1 mg %) in 'Downer' animals which were fed with 15% crude protein.

Warnock et al. (1978) reported that the pregnant cows had significantly lower serum calcium concentration than non-pregnant cows and 'Downer Cows' had significantly still lower serum calcium concentration than the above animals. The concentration of serum calcium of 200 culled dairy cows on arrival at abbatoir ranged from 1.37 to 2.55 m mol/L with a mean value of 2.13 m mol/L.

Rao et al. (1991) reported that the plasma calcium values in 'Downer Cows' recumbent for two and seven days were respectively 9.0 ± 0.44 and 9.4 ± 1.20 mg/dl while the normal value was 9.3 ± 0.90 mg/dl.

2.6.2.4 Inorganic phosphorus

'Downer Cow' Syndrome was considered a special form of milk fever often with low serum phosphorus levels (Hallgren, 1955).

Robertson et al. (1956) reported that a low plasma inorganic phosphorus was noted in prolongedly recumbent cows.

Johnson (1962) stated that phosphorus level in 'Downer Cow' Syndrome could be critical but the value was not recorded.

Curtis et al. (1970) observed that hypophosphataemia was consistent during the initial recumbency and phosphorus level returned to normal within 24 to 48 hours of treatment. However few cases were found to have low serum phosphorus level even after the initial treatment and they were given phosphorus parentally.

Roine et al. (1973) stated that alert sternally recumbent cows showed significantly lower mean serum inorganic phosphorus level compared to the somnolent sternally recumbent animals.

The serum phosphorus concentration in 'Downer Cows' was less than that found in pregnant beef cows during the period of starvation (Caple et al., 1977).

2.6.2.5 Magnesium

Johnson (1962) stated that the serum magnesium level in 'Creeper Cow' was found to be critical.

Roine et al. (1973) reported that sternally recumbent but alert group of cows exhibited a high serum magnesium level ranging from 2.3 to 3.1 mg %.

Warnock et al. (1978) observed that the serum magnesium concentration among 'Downers' less than six months pregnant decreased during starvation but did not change in cows pregnant more than six months.

Blood et al. (1989) observed that the blood magnesium level in 'Downer Cows' was within the normal range for cattle.

Rao et al. (1991) reported that the plasma level of magnesium in 'Downer Cows' was almost comparable to those of the control group. The values for the control and for 'Downers' recumbent for two and seven days were 1.22 $\pm$ 0.26, 1.14 $\pm$ 0.20 and 1.19 $\pm$ 0.33 mg/dl, respectively.

2.6.2.6 Total protein, Albumin and Albumin/Globulin Ratio (A/G Ratio)

Rosenberger (1958) stated that a deficiency in protein metabolism could be a major cause of 'Downer Cow' Syndrome.

Bjorsell et al. (1969) found a significant decrease in plasma protein between the first and second visit in cows that did not responded to treatment in 'Downer Cow' Syndrome.

According to Warnock et al. (1978) 'Downers' at the abattoir did not show any significant changes in the total serum protein concentration in 'Downer Cow' Syndrome during starvation periods.

2.6.2.7 Sodium

Hallgren (1959) observed that there was no significant difference in serum sodium concentration between cows with different types of 'Downer Cow' Syndrome or milk fever except a significantly higher plasma sodium concentration in cases of parturient paresis with convulsion.

Julien et al. (1977) could not detect any change in the blood sodium level in 'Downer Cow' Syndrome.

Narayana et al. (1977) observed normonatraemia in 'Downer Cows' and the mean plasma sodium value in four cases of 'Downer Cows' was 146.75 $\pm$ 3.42 mEq/L.

Fenwick (1986) observed no significant change in plasma sodium concentration in non-alert 'Downer Cows'.

No significant difference in serum sodium concentration between different type of 'Downer Cows' and milk fever cases could be observed by Fenwick (1990).

2.6.2.8 Potassium

Garm (1950) reported that hypokalaemia was observed in alert recumbent cows.

Hypokalaemia associated with delayed recovery in 'Downer Cows' was recorded by Hallgren (1955) and Van der Walt (1966).

Johnson (1962, 1963 and 1967) hypothesized that hypopotassaemia could be involved in the pathogenesis of 'Downer Cow' Syndrome.

Fenwick (1969) obtained plasma potassium levels ranging from 2.10 to 5.90 mEq/L in 138 cases of 'Downers' and there appeared to be a definite increase in incidence of 'Downer Cows' and death in them with decreasing plasma potassium level.

Jonsson and Pehrson (1969) reported that hypokalaemia was noted in alert recumbent animals.

Kronfeld (1974) reported that hypokalaemia was present in many cases of 'Downer Cow' Syndrome.

Fenwick (1977) observed low blood potassium level in almost all cases of non-alert 'Downer' cases studied.

day of the disease in experimentally induced 'Downer Cow' Syndrome in cattle.

Andrews (1986) stated that in the presence of excessive muscle damage proteinuria was observed in 'Downer Cows'.

2.7.2 Glucose

Narayana et al. (1977) observed glucosuria which subsided in four to seven days in two out of four cases of 'Downer Cow' Syndrome.

According to Prasad et al. (1989) glucosuria and myoglobinuria were present in experimentally induced 'Downer Cow' Syndrome.

2.7.3 Ketone bodies

Ketone bodies were found positive in urine sample of one of the four cases of 'Downer Cow' Syndrome reported by Narayana et al. (1977).

Blood et al. (1989) stated that there may be moderate ketonuria present in 'Downer Cow' Syndrome.

2.8 Observations on dung-diseased

Fenwick (1986) reported that all the non-alert 'Downer Cows' under observation developed mucoid faeces after one or two days of recumbency, which in many cases contained bloodspots.

Prasad (1987) reported that parasitic infection was negative in one dairy crossbred cow aged 5 to 8 years which became a 'Downer Cow'.

Materials and Methods

MATERIALS AND METHODS

3.1 Materials

Fourteen clinical cases of 'Downers' in crossbred dairy cows three to thirteen years of age from Trichur district were selected at random and utilized for the present study. Their body weight ranged from 250 to 300 kg and were maintained under average conditions of feeding and management in the field. The study extended over a period of 15 months from April 1992 to June '93. Detailed clinical examination of each animal was conducted and observations recorded. Fourteen healthy crossbred cows of similar age group and body weight maintained under identical conditions of feeding and management from the areas from which the clinical cases were studied were selected at random and utilized as the healthy controls.

3.2 Sampling and analysis

Samples of blood, urine and dung from the animals of the healthy and diseased groups were collected and analysed on the same day using standard procedures recommended.

3.2.1 Blood

Samples of 15 ml of whole blood from each animals were

collected in clean, dry 20 ml capacity screwcaped test tubes using 2.5% solution of sodium citrate 1.7 ml as anticoagulant. Samples of 15 ml whole blood were also collected from the above animals without using any anticoagulant and were allowed to clot. Plasma/serum was separated from the samples collected and stored in refrigerator until analyses were completed.

For estimation of glucose 3.0 ml of whole blood was collected in clean, dry 5 ml capacity vials using 15 mg sodium fluoride as anticoagulant.

For haematological studies 3.0 ml of whole blood from each animal was collected in clean, dry 5 ml capacity vials using 3 mg sodium citrate as anticoagulant.

Haematological parameters were determined as per the method of Schalm et al. (1975),

Estimation of glucose, urea nitrogen, calcium, phosphorus, magnesium, total protein and albumin levels in the blood were made following the method of Folin and Wu (1920), Diacetylmonoxime method (Wybenga, 1971), Roe and Kahn (1929), Fiske and Subbarow (1925), Titan yellow method (Neill and Neilly, 1956) as cited by Oser (1971), Inchiosa (1964) and Doumas (1971), respectively. Estimation of plasma sodium and

potassium levels were carried out as per the method of Oser (1971).

All the above biochemical analyses were carried out using Klett Summerson photoelectric colorimeter under standard conditions of operation, as recommended.

Statistical analyses were conducted according to the methods described by Snedecor and Cochran (1967).

3.2.2 Urine

Using freshly collected 50 ml samples of urine from each animal analyses were carried out to detect the presence of pathological constituents as per Benjamin (1985).

3.2.3 Dung

Using freshly collected samples of dung from each animal microscopical examination for the presence of parasitic ova was carried out as per Sastry (1985).

Results

RESULT

Result of analyses of different parameters studied in healthy control and diseased animals are presented in tables one to eight.

Analyses of the data indicated that out of fourteen animals studied seven were Jersey, five Swiss-Brown and two Holstein-Friesian Crossbreds. Incidence rate was found more during summer.

4.1 Clinical signs

Animals involved in the present study were all bright and alert with no evidence of any systemic disturbances. The respiratory rate ranged from 35 to 45/min. and pulse rate was within 65 to 70/min. Rectal temperature in all the cows were within 100.6 to 102.2°F. Conjunctival mucous membrane was pale roseate. Rumination was 3 to 5/5 min. with normal defecation and micturition but there was slight reduction in feed and water intake and wasting. Muzzle secretion was reduced in eight cows. All the 'Downer Cows' were in sternal recumbency for at least 24 to 48 hours, except in two cases, one was down for 3 days and the other for 5 days. Five cows were in advanced pregnancy and nine were in immediate post-partum

period. All the cows were exhibiting hind-quarter weakness and struggle to get up with their fore-quarter efforts. In one animal a characteristic flexed right fetlock was observed (Fig.1) and in one cow the right hindleg was extended laterally from the body (Fig.2) and were flat on their belly. Both these cows were in advanced pregnancy stage.

4.2 Observations on blood

4.2.1 Haematological

4.2.1.1 Erythrocyte Sedimentation Rate (ESR)

Mean value of ESR of the healthy control animals was 5.79 ± 0.65 mm/24 hour (Table 5).

The mean value of ESR in animals of diseased group was 5.29 ± 0.52 mm/24 hours (Table 5). The difference in the ESR values between the healthy and diseased animals was not significant.

4.2.1.2 Packed Cell volume (PCV)

Mean value of PCV of the animals of the healthy control group was 29.86 ± 0.62 % (Table 5).

The mean value of PCV of the diseased group of 'Downer Cows' was found to be 34.93 ± 1.53 % (Table 5). The

difference between values of PCV of animals of the healthy and diseased groups were highly significant ($P<0.01$).

4.2.1.3 Haemoglobin (Hb)

Mean value of haemoglobin level in healthy control animals was 11.17 $\pm$ 0.23 gm % (Table 5).

Its mean value in diseased animals was 12.20 $\pm$ 0.35 gm % (Table 5). Analyses of the data showed that the mean value of Hb of the diseased group was significantly higher than the mean value for healthy control animals ($P<0.05$).

4.2.1.4 Red Blood Cells (RBC)

Mean value of RBC in healthy control group was 6.21 $\pm$ 0.31 x 10^6/cmm (Table 5).

The mean value of RBC in the diseased group of animals was 6.85 $\pm$ 0.49 x 10^6/cmm (Table 5). Analyses of the data did not reveal any significant difference between the values of the two groups.

4.2.1.5 White Blood Cells (WBC)

Mean value of WBC was 4.83 $\pm$ 0.29 x 10^3/cmm in healthy control animals (Table 5).

The mean value of WBC in the diseased 'Downer Cows'

was 4.42 ± 0.24 x 10^3/cmm (Table 5). Analyses of data indicated no significant difference between the values of the animals of the healthy control and diseased group.

4.2.1.6 Differential Leukocytes Count (DLC)

4.2.1.6.1 Lymphocytes (L)

Mean value of lymphocytes count in the healthy control animals was 62.57 ± 2.43 % (Table 5).

The mean value of lymphocytes for the diseased 'Downer Cows' was 56.64 ± 2.92 % (Table 5). The difference between the values for healthy and diseased animal groups was not significant.

4.2.1.6.2 Neutrophils (N)

Mean value of neutrophils count for the healthy control animals was 30.00 ± 2.16 % (Table 5).

The mean value of neutrophil count for the diseased group of cows was 40.21 ± 2.91 % (Table 5). Analyses of the data showed that the neutrophils count of diseased group was found significantly higher ($P<0.05$) than the value of the animals of the healthy control group.

4.2.1.6.3 Eosinophils (E)

Mean value of eosinophils in healthy control cattle was 6.71 ± 0.85 % (Table 5).

The mean value of eosinophils in the diseased cattle was 2.43 ± 0.65 % (Table 5). Analyses of the data showed that the value of healthy was found significantly higher ($P<0.05$) than the value for the diseased 'Downer Cows'.

4.2.1.6.4 Basophils (B)

Mean value of basophils in healthy control animals was 0.21 ± 0.11 % (Table 5).

The mean value of basophils in the diseased 'Downer Cows' was 0.29 ± 0.08 % (Table 5). No significant difference in the values of basophils were observed between the healthy and diseased group of animals.

4.2.1.6.5 Monocytes (M)

Mean value of monocytes in the healthy control animals was 0.50 ± 0.17 % (Table 5).

The mean value of monocytes count of the diseased 'Downer Cows' was 0.57 ± 0.16 % (Table 5). No significant difference was evident between the values of the animals of the healthy and diseased group.

4.2.2 Biochemical

4.2.2.1 Blood glucose

The mean blood glucose level of healthy control animals was found to be 49.94 ± 1.34 mg/% (Table 6).

In 'Downer Cows' the mean blood glucose value was 48.85 ± 1.29 mg %. The difference between the values of the animals of the two groups was not significant (Table 6).

4.2.2.2 Blood Urea Nitrogen (BUN)

The value of blood urea nitrogen in healthy control group was found to be 21.92 ± 2.24 mg % (Table 6).

In the diseased group the value of BUN was 17.29 ± 1.74 mg % (Table 6). Analyses of the data did not reveal any significant differences between healthy control and the diseased group of animals.

4.2.2.3 Serum Calcium (Ca)

Mean value of serum calcium in healthy control group was found to be 9.71 ± 0.21 mg % (Table 6).

The mean value of serum calcium in cases of 'Downer Cow' was found to be 8.53 ± 0.27 mg % (Table 6). The

difference between the groups of healthy control and diseased 'Downer Cows' was highly significant ($P<0.01$).

4.2.2.4 Phosphorus

The mean value of serum phosphorus in animals of the healthy control group was 5.25 $\pm$ 0.23 mg % (Table 6).

The mean value of serum phosphorus level in the diseased group was 4.14 $\pm$ 0.25 mg % (Table 6). The difference between the values of the two groups was highly significant ($P<0.01$).

4.2.2.5 Serum magnesium

The mean value of serum magnesium level in healthy control animals was 2.28 $\pm$ 0.12 mg % (Table 6).

The mean value of serum magnesium in 'Downer Cows' was found to be 1.99 $\pm$ 0.12 mg % (Table 6). Analyses of the data on serum magnesium level did not reveal any significant difference between the animals of the healthy control and diseased groups.

4.2.2.6 Total serum protein, albumin and albumin/globulin Ratio (A/G Ratio)

Mean values of total protein, albumin and A/G ratio in

the serum of health control animals were found to be 7.89 ± 0.32, 3.38 ± 0.13 gm % and 0.80 ± 0.07, respectively (Table 6).

Respective mean values of total serum protein, albumin and A/G ratio in the affected 'Downer Cows' were 7.01 ± 0.14, 2.54 ± 0.13 gm % and 0.60 ± 0.07 (Table 6).

Significant difference in the values of total serum protein of the animals of the healthy control group and diseased 'Downers' was evident ($P<0.05$). Highly significant difference ($P<0.01$) in the values of serum albumin level between the two groups was observed. The difference in the value of A/G ratio between the above group was not significant.

4.2.2.7 Plasma Sodium

Mean value of plasma sodium in the healthy control group was 134.81 ± 1.26 mEq/L (Table 6).

In animals of the diseased group the mean value of plasma sodium level was 133.76 ± 1.29 mEq/L (Table 6). The difference between the values of the two groups was not significant.

4.2.2.8 Plasma Potassium

Mean value for plasma potassium in healthy control cattle was 4.73 ± 0.20 mEq/L (Table 6).

The mean value of plasma potassium level in case of animals of 'Downer Cow' was 4.39 ± 0.31 mEq/L (Table 6). The difference between healthy control and 'Downer Cows' was not significant.

4.3 Observations on urine-pathological constituents

4.3.1 Protein

Presence of protein was not detected in the urine samples collected from any of the animals of the healthy control group (Table 7).

Protein was found positive in urine samples collected from two cases out of fourteen cases of 'Downer Cow' Syndrome studied (Table 8).

4.3.2 Glucose

On analysis of the urine samples glucosuria was ruled out in all the fourteen healthy control cows (Table 7).

The urine samples were found positive for glucose in two cases of 'Downer Cows' and the rest of the twelve cases

were negative for presence of glucose in the samples of urine (Table 7).

4.3.3 Ketone bodies

Urine samples collected from any of the animals of healthy control groups did not reveal the presence of ketone bodies (Table 7).

Presence of ketone bodies was positive in one and traces in another in the urine samples analysed from the fourteen cases of 'Downer Cows' (Table 8).

4.3.4 Blood

All the urine samples collected from animals of healthy control and diseased groups were negative for presence of blood (Tables 7 and 8).

4.3.5 Bile pigments and bile salt

All samples of urine collected from animals of the healthy control and diseased groups were negative for the presence of bile pigments and bile salt (Tables 7 and 8).

4.4 Observations on dung

Freshly collected samples of dung from healthy control animals and diseased 'Downer Cows' on microscopical examination were negative for any parasitic ova (Tables 7 and 8).

Table 1. Haematological values of healthy control animals

Sl. No.	Animal No.	ESR mm/ 24 hr	PCV %	Hb gm %	RBC million/ cmm	WBC thousand/ cmm	DLC %				
							L	N	E	B	M
1.	9 B	5	28	10.0	5.0	4.0	52	40	8	0	0
2.	10 B	9	31	11.0	5.0	4.3	60	30	9	0	1
3.	11 B	5	28	10.2	4.6	4.8	67	23	10	0	0
4.	12 B	8	33	12.4	5.0	4.8	72	22	6	0	0
5.	14 B	5	32	12.2	7.0	6.5	68	31	0	1	0
6.	16 B	6	30	11.2	7.9	4.6	62	35	2	0	1
7.	18 B	4	28	11.8	5.9	5.4	59	35	5	0	1
8.	19 B	6	31	12.4	8.3	4.2	49	43	8	0	0
9.	20 B	4	27	10.8	7.7	4.3	68	24	7	1	0
10.	21 B	4	35	11.8	6.8	6.9	70	22	7	0	1
11.	24 B	4	28	10.8	5.6	4.7	61	30	7	0	2
12.	25 B	6	30	11.4	6.0	6.2	66	25	9	0	0
13.	26 B	12	28	10.2	6.1	2.8	45	42	12	1	0
14.	28 B	3	29	10.2	6.1	4.1	77	18	4	0	1
Mean ± SE		5.79 ±0.65	29.86 ±0.62	11.17 ±0.23	6.21 ±0.31	4.83 ±0.29	62.57 ±2.43	30.00 ±2.16	6.71 ±0.85	0.21 ±0.11	0.50 ±0.17

Table 2. Haematological values of diseased 'Downer Cows'

Sl. No.	Animal No.	ESR mm/ 24 hr	PCV %	Hb gm %	RBC million/ cmm	WBC thousand/ cmm	DLC %				
							L	N	E	B	M
1.	1/92	10	36	12.6	5.9	4.7	57	40	1	0	2
2.	2/92	6	25	9.3	5.5	3.7	59	36	3	1	1
3.	3/92	8	31	12.2	9.1	3.1	48	50	2	0	0
4.	4/92	6	34	11.8	5.9	4.6	40	58	0	1	1
5.	1 A	3	46	14.4	7.8	3.3	59	41	0	2	0
6.	2 A	6	36	12.2	5.4	4.2	48	50	0	0	2
7.	4 A	4	30	11.6	5.4	4.6	67	26	6	0	1
8.	5 A	3	38	13.8	8.3	4.5	61	35	4	0	0
9.	6 A	4	44	13.4	7.8	4.8	47	45	8	0	0
10.	7 A	5	38	12.5	11.5	4.8	45	53	2	0	0
11.	8 A	6	34	12.0	5.3	4.6	52	45	3	0	0
12.	9 A	4	28	10.2	5.2	3.8	72	28	0	0	0
13.	10 A	5	38	13.0	7.2	6.9	79	20	1	0	0
14.	12 A	4	31	14.8	5.6	4.3	59	36	4	0	1
Mean ± SE		5.29 ±0.52	34.93 ±1.53	12.20 ±0.35	6.85 ±0.49	4.42 ±0.24	56.64 ±2.92	40.21 ±2.91	2.43 ±0.65	0.29 ±0.08	0.57 ±0.16

Table 4. Biochemical values of diseased 'Downer Cows'

Sl. No.	Animal No.	Blood glucose mg %	Bun mg %	Ca mg %	P mg %	Mg mg %	Total protein gm %	Albumin gm %	A.G ratio	Na mEq/L	K mEq/L
1.	1/92	50.0	30.00	8.5	3.50	2.80	7.20	2.56	0.55	126.90	3.02
2.	2/92	52.5	25.00	8.8	4.00	2.66	7.02	2.42	0.53	135.13	6.22
3.	3/92	47.1	29.00	6.47	3.73	1.66	7.93	2.46	0.45	132.75	4.83
4.	4/92	40.0	20.00	8.5	3.50	1.33	7.25	2.48	0.52	135.13	3.81
5.	1 A	48.3	13.96	8.0	6.42	2.00	6.43	2.38	0.59	132.75	4.56
6.	2 A	50.0	12.88	8.0	3.57	2.00	7.07	2.31	0.49	126.50	4.18
7.	4 A	50.0	14.60	7.0	3.85	1.50	7.86	2.84	0.57	143.75	3.04
8.	5 A	55.0	13.96	9.0	3.33	1.60	7.29	2.41	0.49	138.00	6.08
9.	6 A	45.0	12.88	8.0	3.33	1.50	6.86	2.35	0.52	138.00	2.66
10.	7 A	50.0	13.96	10.0	3.33	2.20	7.28	2.87	0.65	129.38	4.08
11.	8 A	55.0	10.74	9.39	4.38	2.00	6.43	1.57	0.32	129.38	3.71
12.	9 A	41.0	11.65	10.0	4.58	2.50	6.86	2.26	0.49	135.13	4.18
13.	10 A	45.0	11.91	9.0	5.19	2.33	6.42	2.89	0.82	138.00	5.77
14.	12 A	55.0	22.56	8.77	5.19	1.82	6.21	3.69	1.46	132.25	5.36
Mean ± SE		48.850 ±1.295	17.293 ±1.744	8.531 ±0.268	4.136 ±0.246	1.993 ±0.122	7.008 ±0.139	2.535 ±0.125	0.603 ±0.072	133.761 ±1.299	4.393 ±0.305

Table 5. Comparison of haematological values between healthy controls and 'Downer Cows'

Parameters	Healthy control animals Mean ± SE	Diseased animals Mean ± SE	't' value
ESR (mm/24 hr)	5.786 ± 0.648	5.286 ± 0.518	0.6028^{NS}
PCV (%)	29.857 ± 0.619	34.929 ± 1.533	3.0336**
Hb (gm %)	11.171 ± 0.228	12.200 ± 0.354	2.4420*
RBC ($x10^6$/cmm)	6.207 ± 0.311	6.850 ± 0.498	1.0937^{NS}
WBC ($x10^3$/cmm)	4.829 ± 0.293	4.421 ± 0.241	1.0724^{NS}
DLC : L	62.571 ± 2.427	56.643 ± 2.923	1.5612^{NS}
DLC : N	30.000 ± 2.156	40.214 ± 2.909	2.8208**
DLC : E	6.714 ± 0.848	2.429 ± 0.652	4.0062**
DLC : B	0.210 ± 0.110	0.290 ± 0.080	-- NS
DLC : M	0.500 ± 0.170	0.570 ± 0.160	-- NS

(* indicate P<0.05)
(** indicate P<0.01)
(NS Non-significant)

Table 6. Comparison of biochemical values between healthy controls and 'Downer Cows'

Parameters	Healthy control animals Mean ± SE	Diseased animals Mean ± SE	't' value
Blood glucose (mg %)	49.936 ± 1.342	48.850 ± 1.295	0.5811^{NS}
BUN (mg %)	21.914 ± 2.235	17.293 ± 1.744	1.6300^{NS}
Ca (mg %)	9.704 ± 0.205	8.531 ± 0.268	3.4797**
P (mg %)	5.249 ± 0.226	4.136 ± 0.246	3.3314**
Mg (mg %)	2.279 ± 0.123	1.993 ± 0.122	1.647^{NS}
Total protein (gm%)	7.886 ± 0.323	7.008 ± 0.139	2.4970*
Albumin (gm %)	3.375 ± 0.129	2.535 ± 0.125	4.6839**
A.G ratio	0.804 ± 0.720	0.603 ± 0.073	1.9559^{NS}
Na (mEq/L)	134.810 ± 1.264	133.761 ± 1.299	0.5787^{NS}
K (mEq/L)	4.727 ± 0.204	4.393 ± 0.305	0.9113^{NS}

(* indicate P<0.05)
(** indicate P<0.01)
(NS Non-significant)

Table 7. Dung examination and urinalysis in Healthy Animals

Sl. No.	Animal No.	Dung sample examination	Urinalysis					
			Protein	Glucose	Ketone	Bile pigment	Bile salt	Blood
1.	9 B	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
2.	10 B	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
3.	11 B	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
4.	12 B	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
5.	14 B	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
6.	16 B	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
7.	18 B	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
8.	19 B	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
9.	20 B	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
10.	21 B	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
11.	24 B	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
12.	25 B	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
13.	26 B	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
14.	28 B	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)

(-ve) Negative

Table 8. Dung examination and urinalysis in 'Downer Cows'

Sl. No.	Animal No.	Dung sample examination	Urinalysis					
			Protein	Glucose	Ketone	Bile pigment	Bile salt	Blood
1.	1/92	(-ve)	(-ve)	(+ve) +	(-ve)	(-ve)	(-ve)	(-ve)
2.	2/92	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
3.	3/92	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
4.	4/92	(-ve)	(+ve) +	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
5.	1 A	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
6.	2 A	(-ve)	(-ve)	(+ve) +	(-ve)	(-ve)	(-ve)	(-ve)
7.	4 A	(-ve)	(-ve)	(-ve)	Traces	(-ve)	(-ve)	(-ve)
8.	5 A	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
9.	6 A	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
10.	7 A	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
11.	8 A	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
12.	9 A	(-ve)	(+ve) ++	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)
13.	10 A	(-ve)	(-ve)	(-ve)	(+ve) ++	(-ve)	(-ve)	(-ve)
14.	12 A	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)	(-ve)

(+ve) Positive
(-ve) Negative

Fig.1 A characteristic flexed right fetlock

170679

Fig.2 Right hindleg extended laterally away from the body

Fig.3 HAEMATOLOGICAL VALUES - COMPARISON BETWEEN HEALTHY AND 'DOWNER COWS'

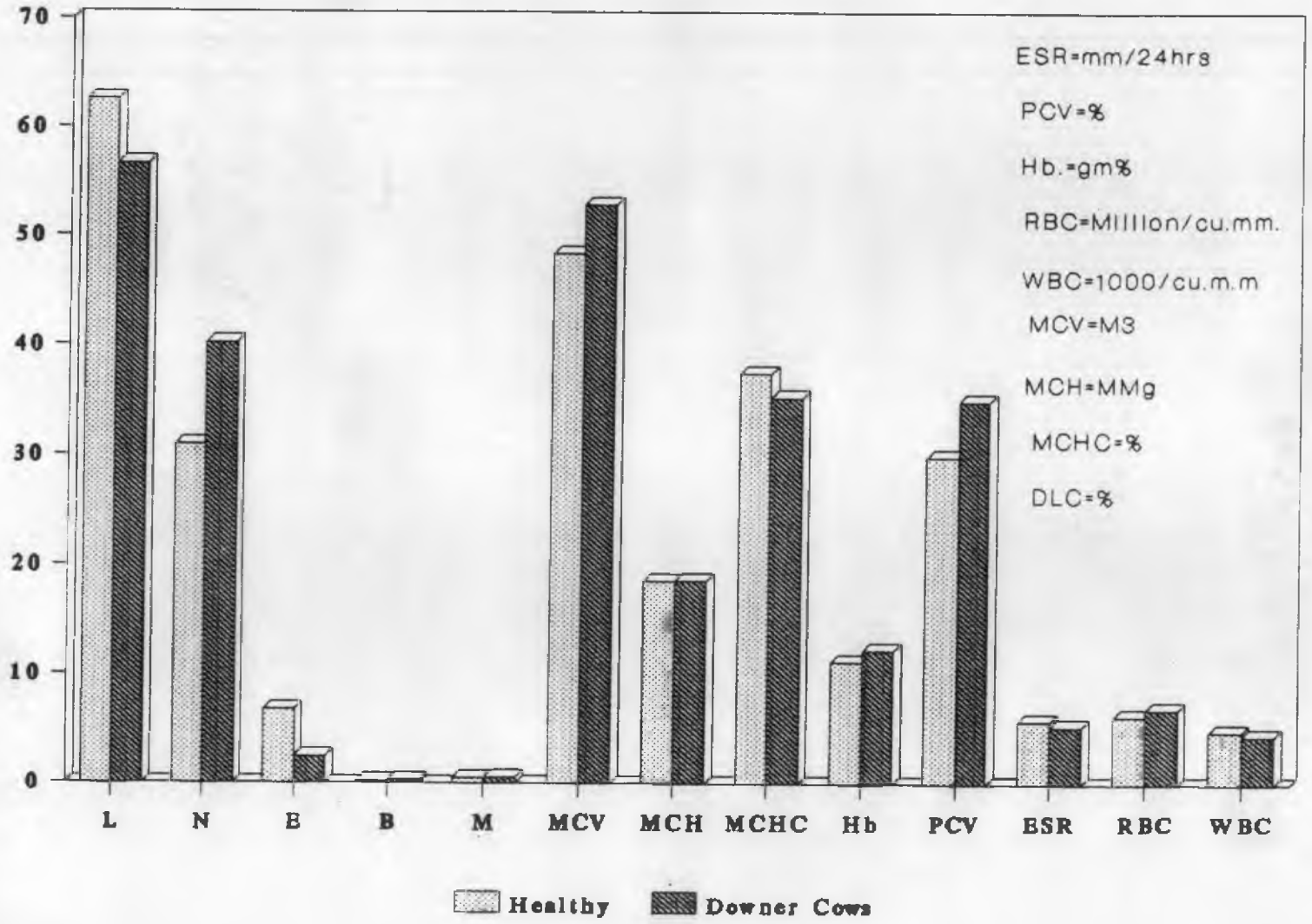
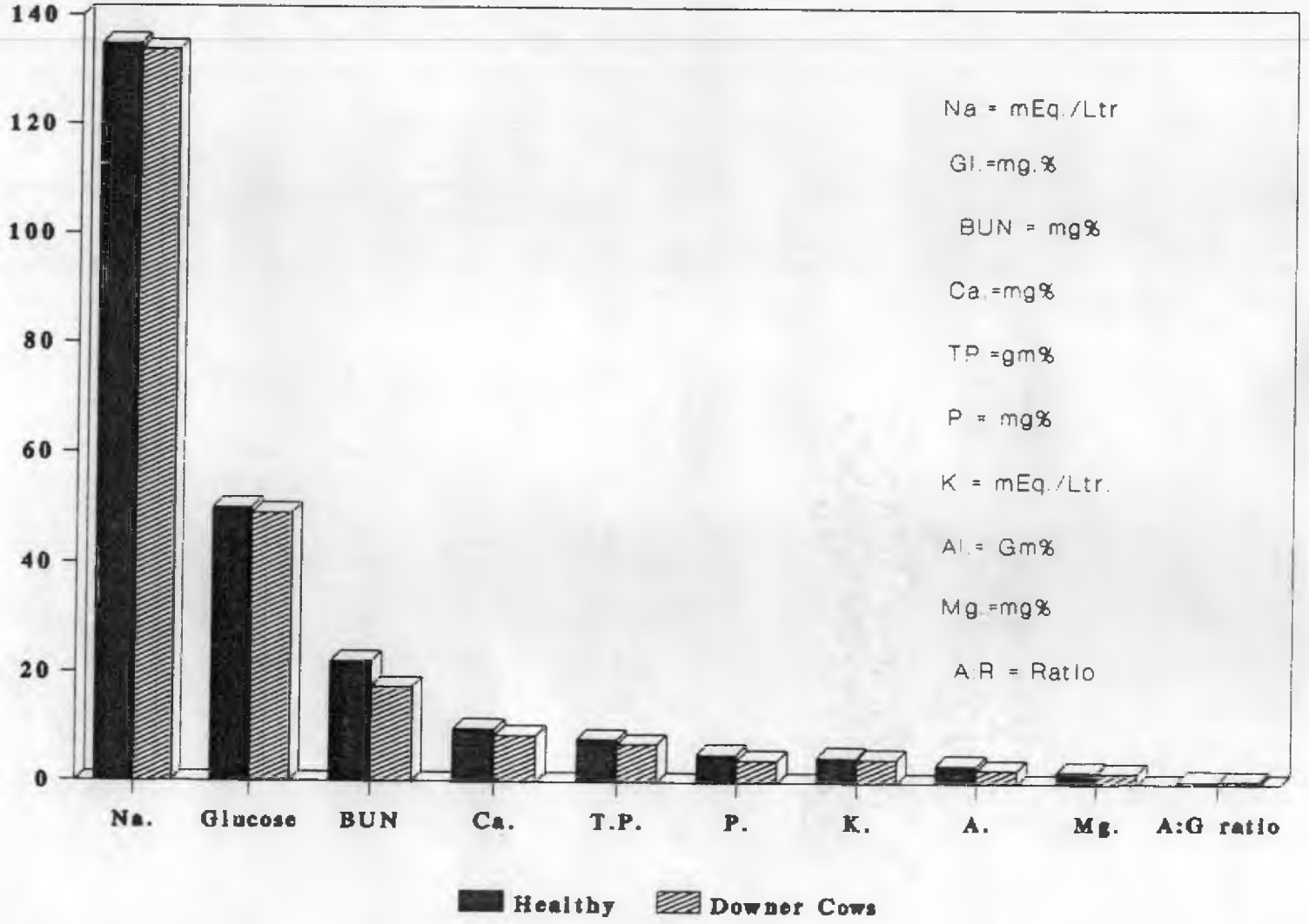


Fig.4 BIOCHEMICAL PROFILE - COMPARISON BETWEEN HEALTHY AND 'DOWNER COWS'



Discussion

DISCUSSION

5.1 Clinical signs

'Downer Cow' Syndrome is an important metabolic disease mainly affecting high yielding dairy cows at any stage of pregnancy/lactation cycle without any uniform pattern of development of clinical signs excepting sternal recumbency. The clinical data were within physiological limit. Earlier workers also made similar observations (Rosenberger, 1958, Curtis et al., 1970 and Allen and Davies, 1981). The clinical signs observed in the present study like sternal recumbency for at least 24 to 48 hours, bright and alert appearance without any systemic disturbances agree with the observations made by the above authors. Hindquarter weakness, strenuous struggling to get up mostly with forequarter efforts and inability to regain feet noticed in the present investigation were supported by Rosenberger (1958), Johnson (1962), Allen and Davies (1981) and Andrews (1986). Flexion of hind-fetlock in one cow was in agreement with the observations of Rosenberger (1958), Johnson (1962), Curtis et al. (1970), Allen and Davis (1981): Cox et al. (1982) and Cox and Marion (1992). However, this characteristic symptom was not observed in the other 13 affected cows. Hindquarter weakness permitted hindleg to extend under the belly along the sides or back away

from the body was supported by Johnson (1963). Reduced muzzle secretion in affected cows agree with the finding of Johnson (1962). This could be due to dehydration caused by reduced feed and water intake and stressor effects. Breathing heavily and moaning on slight exertion were observed by Rosenberger (1958) whereas Johnson (1962) noticed stretching of the neck low to the ground, open mouth and protrusion of the tongue. However, these signs were not noticed in the present study.

Variations in the clinical signs in individual animals are attributable to factors such as breed, age, feeding, management, environment, milk yield, climate, biochemical and pathological changes. Rosenberger (1958) also could not draw conclusion on typical clinical signs of the disease due to the above factors.

5.2 Observations on blood

5.2.1 Haematological

5.2.1.1 Erythrocyte sedimentation rate (ESR)

The mean value of erythrocyte sedimentation rate obtained from healthy animals in the present study was well within the range reported by Greatorex (1957).

Difference in the ESR values between the healthy animals and the 'Downer Cows' in the present study was not

significant. Corresponding values for the 'Downer Cows' for comparison were not available in the literature consulted.

5.2.1.2 Packed cell volume (PCV)

Mean value of PCV for the healthy control cows was comparable to the values for Ongole cows reported by Rao et al. (1981) and in advance pregnant dairy cows by Prasad et al. (1987).

A highly significant difference ($P<0.01$) in the value of PCV between the healthy control and diseased 'Downer Cows' was observed in the present study. The affected animals had higher values which were in agreement with the values in field cases of non-alert 'Downers' reported by Fenwick (1986) and Pandey and Parai (1988) and in experimentally induced 'Downers' by Prasad et al. (1989). The high value of PCV could be due to the effect of dehydration as was observed in goats under similar conditions by Kataria et al. (1991). Swenson (1977) observed release of catecholamines such as epinephrine and norepinephrine during excitement and produce increase in the value of PCV due to spleenic contraction. Fenwick (1992a) also reported increased PCV as an abnormal finding in 'Downer Cows' but could not explain whether this is due to plasma loss or increase in mean corpuscular volume. Rydberg (1969) and Daniel (1979) reported increased PCV in

experimental hypocalcaemic states. The present study also indicated hypocalcaemia in 'Downer Cows'.

5.2.1.3 Haemoglobin (Hb)

Mean haemoglobin level in healthy animals obtained in the present study was comparable to the values in normal cattle reported by Greatorex (1957), Wingfield and Tumbleson (1972), Schalm (1975), Sreekumar and Thomas (1990) and in healthy Kankrej heifers by Gurjar et al. (1990).

A significant increase ($P<0.05$) in the Hb content in the diseased cows obtained in the present study was in agreement with the finding of Prasad et al. (1989) and this could be due to spleenic contraction associated with the strenuous efforts made by the animal to get up during recumbency, as was noticed in the case of increased PCV (Swenson, 1977). Circulatory deficit observed by Rydberg (1969) and Daniel (1979) could be an added factor in increased Hb values in 'Downer Cows'.

5.2.1.4 Red blood cell (RBC)

Mean value of RBC count in healthy control cows obtained in the present study was comparable to the values reported by Greatorex (1957) and Payne and Maitra (1981).

There was slight increase in the RBC count in diseased animals, but it was not statistically significant. Blood et al. (1989) also could not observe any change in the RBC count in 'Downer Cows'.

5.2.1.5 White blood cell (WBC)

Mean value of WBC count in healthy cows was comparable to the value reported by Prasad et al. (1987).

Mean value of WBC count between the healthy control and the diseased cows in the present study revealed no significant difference. Blood et al. (1989) also could not find any change in WBC count in 'Downer Cows'. Moreover, there was no evidence of systemic reaction in any of the 'Downer Cows' studied.

5.2.1.6 Differential Leukocytes Count (DLC)

Mean value of DLC obtained in case of healthy cows was comparable to the values in adult dairy cattle reported by Greatorex (1957), Payne and Maitra (1981), Prasad et al. (1987), Deshpande and Sawant (1987) and Salim and Joshi (1992).

No significant difference in the mean values of basophil and monocytes between the healthy and diseased cows were observed. However, a highly significant ($P<0.01$)

increase in the neutrophil count was observed and this could be due to the stressor response in 'Downer Cows' (Prasad et al., 1989). Further there was a significant ($P<0.05$) decrease in eosinophil count in the diseased cows compared to the healthy control cows. There was a slight reduction in lymphocyte count but was not statistically significant. Schalm (1975) reported neutrophilia, lymphopenia and eosinopenia in all diseased conditions associated with stress.

5.2.2 Biochemical change

5.2.2.1 Glucose

Mean value of blood glucose in the healthy control cows in the present study was well within the ranges previously reported (Payne et al., 1970 and Benjamin, 1985).

Non-significant difference in the blood glucose level observed in the present study concurred with the earlier observations made by Blood et al. (1989). Prasad et al. (1989) observed hyperglycaemia in all the experimentally induced 'Downer Cows' by six hours but came down to normal by 24-48 hours, and attributed hyperglycaemia in earlier period due to excitement, stress and secretion of epinephrine. In the present study samples were drawn from animals which are recumbent for more than 24-48 hours and thus probably sampling

phosphorus level appears to be intimately related to carbohydrate metabolism (Simesen, 1970) and hypophosphataemia may be related to the lower carbohydrate reserves (Caple et al., 1977). Though there was normal blood sugar level the diseased animals exhibited wasting clinically indicative of poor carbohydrate reserve.

5.2.2.5 Magnesium

Mean serum magnesium level obtained in the present study in the healthy cows was comparable to the values for apparently healthy dairy cattle reported by Mylrea and Bayfield (1968), Payne et al. (1970) and Lee et al. (1978).

Non-significant difference between healthy control and 'Downer Cows' observed in the present study concurred with the earlier observations made by Warnock et al. (1978), Blood et al. (1989) Rao et al. (1991). Warnock et al. (1978) reported a decrease in magnesium level in 'Downers' less than six months pregnant starved for seven days at the abattoir where as Gardines (1973) from his experimental study suggested that there are some form of magnesium reserve in the animals which could be greater in cows more than six months pregnant than in non-pregnant cows. This is probably the reason for maintenance of normal magnesium level in 'Downer Cows'

at later stages of the disease had yielded the normal level of blood sugar.

5.2.2.2 Blood Urea Nitrogen (BUN)

Mean value of BUN obtained for the control animals in the present study was comparable to the ranges for healthy dairy cattle reported by Payne et al. (1970), Tumbleson et al. (1972), Kaneko (1980) and Benjamin (1985).

No significant difference in the mean value of BUN between the healthy and diseased groups observed in the present study was in agreement with the observations made by Prasad et al. (1989). However, a fall in BUN in 'Downer Cow' Syndrome was reported by Andrews (1986) and Julien et al. (1977) and stated that this is attributable to the difference in dietary protein content.

5.2.2.3 Calcium

Mean serum calcium level in the control cows obtained in the present study was well within the ranges for healthy cattle reported by Moodie (1960), Mylrea and Bayfield (1968), Payne et al. (1970), Lee et al. (1978) and Kaneko (1980).

A highly significant difference ($P<0.01$) in serum calcium level between the values of healthy control and 'Dowmer Cow' Syndrome was observed in the present study which

was in agreement with the observations reported by Curtis et al. (1970), Fenwick (1977 and 1986) and Warnock et al. (1978). However, Julien et al. (1977); Narayana et al. (1977) and Rao et al. (1991) reported that there was no significant changes in serum calcium level in 'Downers'. Drain of calcium into the colostrum was the main cause for hypocalcaemia in normal cows at parturition (Robertson et al., 1956) or interruption to absorption of calcium from the gut (Marr, 1958) and these could be the reasons for low level of calcium observed in the present study.

5.2.2.4 Phosphorus

Mean inorganic phosphorus level in the control cows obtained in the present observation was comparable to the values for apparently healthy dairy cows reported by Mylrea and Bayfield (1968) and Payne et al. (1970), and for lactating cows by Lee et al. (1978), Kaneko (1980) and Salim and Joshi (1992).

Highly significant difference ($P<0.01$) was evident in the values of phosphorus level between the healthy and 'Downer Cows'. Low level of phosphorus obtained from diseased cows was in agreement with the reports of Hallgren (1955), Robertson et al. (1956)., Johnson (1962), Curtis et al. (1970), Roine et al. (1973) and Caple et al. (1977). Serum

eventhough the appetite and food consumption are reduced and curtailed its dietary supply.

5.2.2.6 Total protein

Mean value of total serum protein in the blood of normal control cows in the present study was well within the ranges reported by Mylrea and Healy (1968), Payne et al. (1970), Schalm (1975), Larson et al. (1980), Green et al. (1982), Singh and Choudhary (1988) and Gujar et al. (1990).

A significant decrease ($P<0.05$) in the value of serum protein was observed in the 'Downer Cows' compared to the value obtained in healthy control cows. Similar observations were reported by Rosenberger (1958) and Bjorsell et al. (1969).

Decreased serum protein could be due to inadequate production (Benjamin, 1985). Malnutrition and hypoproteinaemia during pregnancy and lactation could be due to failure to meet the increased demand (Kaneko, 1980). Fenwick and Daniel (1992b) reported inconsistency in the results of plasma protein from clinical cases and the lack of significant changes in their experimental study suggested that the changes in plasma protein are not necessarily related to the aetiology of 'Downer Cow' Syndrome.

5.2.2.7 Serum albumin

Mean value of serum albumin in healthy control animals in the present observation was comparable to the values obtained in the apparently healthy dairy cows by Mylrea and Healy (1968), Payne et al. (1970 and 1974) and Singh and Choudhary (1988).

A highly significant ($P<0.01$) decrease in the serum albumin level was obtained in the 'Downer Cow' Syndrome and this could be due to inadequate production (Benjamin, 1985). Low level of albumin during pregnancy and lactation could be due to failure to meet the increased demand (Kaneko, 1980) as was noticed in the case of total protein.

5.2.2.8 Albumin/Globulin Ratio (A/G Ratio)

Mean value of A/G ratio obtained in healthy cows in the present observation agree with the reports of Gaikwad et al. (1992).

Though there was slight reduction in the A/G ratio of diseased animals it was not statistically significant. Sherlock (1958) attributed alteration in A/G ratio as the result of increase in total serum globulin brought about by excess tissue breakdown and formation of homologous tissue antibodies. Kaneko (1980) also reported decrease in albumin

level in common forms of dysproteinaemia due to nutritional deficiencies causing abnormal A/G ratio. The present study also showed a decline in albumin and total serum protein level.

5.2.2.9 Plasma sodium

Mean value of plasma sodium obtained in the healthy cows was comparable to the values for apparently healthy dairy cattle reported by Mylrea and Bayfield (1968) and Kaneko (1980).

Non significant difference was observed in the plasma sodium level which was in agreement with the observations reported by Hallgren (1959), Julien et al. (1977), Narayana et al. (1977) and Fenwick (1986).

5.2.2.10 Plasma potassium

Mean plasma potassium level obtained from the healthy cows was comparable to the values reported by Mylrea and Bayfield (1968), Payne et al. (1970 and 1974), Kaneko (1980) and Benjamin (1985).

Though there was decrease in potassium level in diseased animals compared to healthy control the differences was not statistically significant. Garn (1950), Hallgren (1955), Van der Walt (1966), Johnson (1962, 1963 and 1967),

Jonsson and Pehrson (1969), Kronfeld (1974) and Narayana et al. (1977) reported hypokalaemia in 'Downer Cows'. Smith (1990) reported hypokalaemia as the result of depletion of body potassium. Fenwick (1969) suggested prolonged hypocalcaemia as the cause for fall in plasma potassium concentration in 'Downer Cows'. Failure of sampling for a prolonged period is probably the reason for the absence of significant hypokalaemia in 'Downer Cows' studied.

5.3 Observations on urine

In healthy control cows urinalysis did not reveal any pathological constituents.

Among diseased animals urinalysis for pathological constituents did not give any consistent results. Out of 14 diseased animals only two cows showed positive reaction for protein. Rosenberger (1958) also reported that test for urine albumin may reveal all degrees of reaction without any positive correlation to the outcome of individual cases. Curtis et al. (1970) could observe proteinuria only within 48 hours of their becoming recumbent. Kronfeld (1970) and Narayana et al. (1977) reported varying degrees of albuminuria in four cases of 'Downer Cow' Syndrome and suggested that mild degree of renal and skeletal muscle damage as etiology. Andrews (1986) reported that proteinuria was observed only if

muscle damage is present. Absence of albuminuria in other cases studied is possibly due to the lack of renal and muscle damage since samples were drawn early in the disease.

Traces of sugar was found in the urine of only two 'Downer Cows'. Narayana et al. (1977) also could observe positive reaction for sugar only in two cases out of four. The results indicate that glycosuria is not a usual phenomenon in 'Downer Cows'. Prasad et al. (1989) observed glycosuria in all the five experimentally induced 'Downer Cows' and suggested that it is due to hyperglycaemia. But in the present study the blood sugar level was normal.

Urinalysis for ketone bodies revealed mild ketonuria in two 'Downer Cows'. Narayana et al. (1977) also could notice ketonuria only in one case out of four. Blood et al. (1989) stated that there may be moderate ketonuria in 'Downer Cow' Syndrome. Variable results could be due to variations in energy status of the individual animals studied.

Reaction of urine for bile pigments and bile salts was found negative. Literature consulted also did not give any corroborative findings on analysis of urine for bile salts and bile pigments.

5.4 Observations on dung

Microscopic examination of dung samples of healthy control and diseased animals did not reveal any evidence of parasitism and its influence on 'Downer' cases studied.

Summary

SUMMARY

This investigation was undertaken to study the metabolic profile of 'Downer Cow' Syndrome in cattle under field conditions. The clinical findings, observations on blood, urine and dung were the main items of observations.

Fourteen field cases of 'Downer Cow' Syndrome in crossbred dairy cows aged three to thirteen years, ranging in body weight from 250 to 300 kg, from Trichur district were selected at random and utilized for the study. Fourteen apparently healthy crossbred dairy cows of similar age and body weight maintained under similar conditions of feeding and management from the areas from which the clinical cases studied were selected at random and utilized as the healthy controls. Samples of blood, urine and dung from the animals of the healthy and diseased groups were collected and analysed. Haematological changes consisting of ESR, PCV, RBC, WBC and DLC were recorded. Glucose, calcium, phosphorus, magnesium, urea nitrogen, total protein, albumin, albumin/globulin ratio, sodium and potassium in the blood were determined using standard methods. Urinalysis for the presence of pathological constituents and microscopical examination of the dung for presence of parasitic ova were carried out.

Analyses of the data indicated that out of fourteen animals studied incidence was higher in Jersey crossbred during summer seasons. Striking clinical signs were sternal recumbency and hindquarter weakness. Slight reduction in feed and water intake and wasting of body conditions were also noticed. Clinical data were within physiological limit and all the animals involved were bright and alert with no evidence of any systemic disturbances.

A highly significant increase in PCV and significant increase in Hb but no significant increase in ESR, RBC and WBC were observed in 'Downer Cow' Syndrome. Highly significant increase in neutrophils and significant decrease in eosinophils were observed. Biochemical changes in blood included highly significant decrease in calcium, phosphorus and albumin. The decrease in total protein was significant. Variations in blood glucose, urea nitrogen, sodium, potassium, magnesium, albumin/globulin ratio and lymphocytes count were not significant. Urinalysis revealed no consistent result indicative of any systemic involvement. Dung samples were negative for ova of parasites.

Changes in the parameters observed in the 'Downer Cow' Syndrome under the present study suggested that hypocalcaemia, hypophosphataemia, hypoalbuminaemia, hypoproteinaemia were associated with this condition.

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METABOLIC PROFILE OF 'DOWNER COW' SYNDROME

By

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ABSTRACT OF A THESIS

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ABSTRACT

The metabolic profile of 'Downer Cow' Syndrome in field condition was studied.

Fourteen field cases of 'Downers' in crossbred dairy cows aged three to thirteen years, ranging from 250 to 300 kg body weight from Trichur district were selected at random and utilized for the study. Fourteen apparently healthy crossbred dairy cows of similar age group and body weight, maintained under similar conditions of feeding and management from the area from which the clinical cases studied were also selected at random and utilized as the healthy controls. Samples of blood for haematological and biochemical parameters, urine and dung from both healthy and diseased animals were collected and analysed using standard methods.

Analyses of the data from fourteen diseased animals indicated a higher incidence in Jersey crossbred cows during summer season. Prominent clinical signs were sternal recumbency exhibiting hindquarter weakness and reduced feed and water intake. However, the affected animals remained bright and alert with no evidence of any systemic disturbances. The clinical data were within physiological limit.

Highly significant increase in PCV and significant increase in Hb but no significant difference in ESR, RBC and WBC were observed. Lymphopenia, neutrophilia and eosinopenia were observed with no variation in basophils and monocytes counts. Biochemically, hypocalcaemia, hypophosphataemia, hypoproteinaemia and hypoalbuminaemia were obtained from 'Downers' with no significant variation in blood glucose, urea nitrogen, sodium, potassium, magnesium and albumin/globulin ratio. Urinalysis revealed no consistent result indicative of any systemic involvement and no parasitism on dung examination microscopically.