PHYSIOLOGICAL AND HAEMATOLOGICAL RESPONSES OF CROSSBRED MALES UNDER DIFFERENT HOUSING CONDITIONS

THESIS SUBMITTED TO THE
NATIONAL DAIRY RESEARCH INSTITUTE, KARNAL
(DEEMED UNIVERSITY)
IN PARTIAL FULFILMENT OF THE REQUIREMENT
FOR THE DEGREE OF

MASTER OF SCIENCE
IN
DAIRYING
(ANIMAL PHYSIOLOGY)

BY
SOLY M.J.
B.V.Sc. & A.H.

DIVISION OF DAIRY CATTLE PHYSIOLOGY
NATIONAL DAIRY RESEARCH INSTITUTE
(I.C.A.R.)
KARNAL - 132 001 (HARYANA), INDIA.

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Dedicated
to the
Unknown
Farmer

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APPROVED BY

17/7/2001

EXTERNAL EXAMINER

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This is to certify that the thesis entitled, **"PHYSIOLOGICAL AND HAEMATOLOGICAL RESPONSES OF CROSSBRED MALES UNDER DIFFERENT HOUSING CONDITIONS"** submitted by **Mr. SOLY. M. J.** Towards the partial fulfilment of the award of the degree of **MASTER OF SCIENCE** in **DAIRYING (ANIMAL PHYSIOLOGY)** of the **NDRI (Deemed University)**, Karnal, Haryana, India, is a bonafide research work carried out by him under my supervision and no part of the thesis has been submitted for any other degree or diploma.

(SOHANVIR SINGH)
MAJOR ADVISOR & CHAIRMAN
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Dated: June 18th; 2001

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I wish to dedicate this work to the million, of toiling farmers of India, whose sweat is the inspiration and strength for me.

Dated : June....18th....2001.

(Soly. M. J.)

List of Abbreviations

µl	→	Microliter
μm^3	→	Cubic Micrometers
ADG	→	Average Daily Gain
bpm	→	Beats Per Minute
cpm	→	Counts Per Minute
DMI	→	Dry Matter intake
EDTA	→	Ethylene Diamine Tetra Acetic Acid
Hb	→	Haemoglobin
HR	→	Heart Rate
KF	→	Karan Fries
N : L	→	Neutrophil : Lymphocyte
NDRI	→	National Dairy Research Institute
ng	→	Nanogram
PBS	→	Phosphate Buffered Saline
PCV	→	Packed Cell volume
pg	→	Picogram
POPOP	→	1, 4 bis (5 phenyloxazole-2-yl) benzene
PPO	→	2, 5 Diphenyloxazole
RBC	→	Red Blood Cell
RIA	→	Radio Immuno Assay
RR	→	Respiration Rate
RT	→	Rectal Temperature
ST	→	Skin Temperature
TDN	→	Total Digestible Nutrients
THI	→	Temperature Humidity Index
WBC	→	White Blood Cell

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CHAPTER - 1

INTRODUCTION

1. INTRODUCTION

As in any developing country demand for livestock products are increasing rapidly in our country. This increased demand coupled with the burgeoning population is exerting tremendous amount of pressure on the land. So the need of the hour is to increase the productivity in Indian Livestock system, which is notoriously low when compared to the developed nations. So there is tremendous scope for increasing the productivity in our livestock production system also.

To increase productivity a three pronged strategy is employed viz., (i) Breeding which deals with the increasing the genetic potential of the animal. (ii) Nutrition whereby better feeding practices are employed and also by using cheaper alternatives. (iii) Better managemental practices. All the three components have got their limitations and advantages. Improvement through breeding is fast approaching it's limits, as high production and resistance to harsh climatic conditions and diseases will not go together. Better feeding practices are limited by the economic constraints. Thus management practices offer enormous scope for improving the productivity. Improved management practices offer better adaptability to the crossbred animals so that cross breeding can be vigorously followed.

Housing forms an important component of animal management. Essentially what the housing system does is that it modifies the microclimate of the animal system. Thus the essential function of the housing system is to moderate the extremes of climatic stress and give a microclimate which is as close to the thermo-neutral zone so that animal can devote maximum energy towards productive purposes.

During 1960s and 1970s there were many studies on the effect of housing on animal production. But the remarkable success of cross breeding eclipsed the importance of these studies. It is generally assumed that under Indian conditions, except heavy precipitating areas, loose housing system is suitable. But it is conclusively proved that the loose housing system does not afford much protection during extremes of climate.

In North India the minimum temperature during winter goes down as far as 3^0C and in Summer maximum temperature goes up to 48^0C and humidity ranges from 50% to 100%. That is, round the year animals are exposed to all types of climatic extremes.

Loose house system is recommended on the basis of the overall growth performance of the animals. Various studies have pointed out that loose house system does not protect the animals during extremes of climate. In winter nights loose house system is stress full to the animal because of extreme cold and chilly winds whereas in summer, daytime offers extreme stress to the animals in loose house system due to direct solar radiation and the hot wind know as loo. Even with these disadvantages loose housing system showed better growth. This may be due to the fact that loose house system offers very congenial microclimate during winter days and summer nights so that animals are able to recover from the stress they suffered during winter nights and summer days. Moreover studies, which correlate the effect of microclimate and physiological reactions, are very rare. So the present studies aims at providing most comfortable conditions during 24 hours of the day and to monitor various physiological and haemalotogical parameters, which indicate the comfort of animals. The present study concentrate on growing bull calves, which are future breeding bulls and thus contribute 50% genetic potential to the future generations.

The main objectives of the study are:-

To study the physiological, haematological and growth response under existing and modified housing conditions.

To find out the relationship among the physiological, haematological parameters under two different housing conditions.

CHAPTER - 2

REVIEW OF LITERATURE

2 REVIEW OF LITERATURE

In tropical countries where the whether goes to extremes during different seasons of year housing is very important in animal production to reduce the stress during extremes of climate. Animal housing helps in moderating the range of microenvironment to which animals are exposed, thus directly affects the efficiency of animal productivity. The present review focus on suitable housing conditions, parameters which indicate the animal comfort level and the effect of housing on animal production.

2.1 PHYSIOLOGICAL PARAMETERS.

Physiological parameters like respiration rate, heart rate, body temperature and skin temperature give an immediate response to the climatic stress and thus to the level of comfort of the animal. So these observations form an important parameters in measuring the comfort level of the animal and thus the production potential of the animal.

Seth and Miller (1946) reported that increased respiration rate is the first reaction when animals are exposed to environmental temperature above the thermoneutral zone.

Mullick and Kehar (1952) reported higher values for pulse rate, respiratory rate, rectal temperature and lower values of Hemoglobin with the rise in ambient temperature.

Raab *et al.*, (1953) reported the beneficial effect of shade on cattle and buffaloes for lowering down the body temperature during summer conditions

Appleman and Delouche (1958) reported that ambient temperature ranging from 20^0C to 40^0C resulted in an increased rectal temperature

Bianca (1961) reported that with the increasing environmental temperature, the respiration rate continues to rise linearly until it reaches a certain temperature where the rate of increase in respiration rate slows down.

Goswami and Prem Narain (1962) showed that the relative humidity at a constant air temperature affected respiration rate, pulse rate and body

temperature of buffalo bulls. The air temperature affected respiration rate and body temperature at a constant relative humidity but pulse rate remained unaffected.

According to Rao and Mullick (1965) respiration rate, pulse rate and rectal temperature varied greatly with slightest variation in air temperature..

Razdan (1965) observed that respiration rate was affected to a greater degree by climatic factors in Tharparker heifers.

Pandey and Roy (1969) reported significant correlation between rectal temperature and ambient temperature. But there was clear evidence that body temperature did not arise abnormally under conventional management.

Thomas *et al.*, (1972) revealed the effect of shelter on the rectal temperature was different during different months of the year.

According to Thomas *et al.*, (1978) during winter mornings pulse rate in crossbred and buffalo cows was higher inside the barn than that of animal in loose housing. However during afternoon there was no difference in pulse rate between loose housing conditions and in barn.

Amakiri and Funsho (1979) reported that domestic animals exhibited a diurnal rhythm of body temperature, which depends mainly on the climatic conditions. Mean morning (38.62^0C) and late afternoon (39.19^0C) RT for various cattle breeds differed significantly ($P<0.01$).

Canton *et al.*, (1982) reported that in hot weather condition no effective reduction of rectal temperature was achieved with cooled inspired air treatment but a well-designed shade structure was economical than it.

Rectal temperature of Holstein Freisien and Red and White Freisian cows in unprotected from sun were higher at 0900 hr and 1500hrs than the cows kept in full or partial shade but there was no significant difference between the partial and fully shaded groups (Cardoso *et al.*, 1983)

Sharma (1983) observed that maximum temperature didnot show appreciable effect on physiological reaction whereas humidity affected pulse rate as well as respiration rate in Brown Swiss crossbreds in individual stalls.

Sastry and Georgie (1985) concluded that during hot or hot humid conditions loose house environment was better than the barn or shed during night.

Lal *et al.*, (1987) reported significant increase in respiration rate, pulse rate and rectal temperature with increase in ambient temperature and relative humidity in Haryana cattle. The morning values for physiological reactions were lower than the evening values during all the seasons.

Barn type housing caused a lower heat load in hotter climates than the loose house for lactating cows, (Sastry and Georgie, 1988).

According to Patel and Dave (1988) rectal temperature and respiration rate during hot humid season had significant positive correlations with maximum ambient temperature and THI.

Taylor *et al.*, (1988) found that evaporative cooling reduced respiration rate and body temperature faster as compared to shade.

Frazzi (1989) reported that stress was lowest in buildings in which temperature fluctuations were lowest.

The diurnal variation of rectal temperature, rate of respiration and heart rate were significantly higher under open environment as compared to under shed, irrespective of seasons. The adaptability coefficient (on the basis of heat tolerance tests) showed significantly higher adaptability of crossbred calves under shed environment as compared to under open environment. (Parihar *et al.*, 1992)

Wind velocity affected respiration rate, heart rate and rectal temperature negatively and significantly whereas black globe thermometer readings were found to have significant influence on the respiration rate. (Thiagarajan and Thomas 1992)

Singh and Singh (1994) conducted experiment on crossbred male calves with three exotic inheritance to study their heat tolerance coefficient and physiological responses during summer and monsoon seasons altering their housing management. The rate of respiration was recorded significantly higher in all the three groups during monsoon, but no significant variation on rate of respiration of calves was noticed either due to shed or supply of water to the animals

Mishra *et al.*, (1995) reported a correlation coefficient of 0.7069 between ambient temperature and pulse rate and of – 0.5640 between relative humidity and pulse rate in crossbred heifers.

In buffaloes skin temperature increased as the intensity of solar radiation increased and skin temperature was highly correlated with rectal temperature. (Das *et al.*, 1997)

Kumar *et al.*, (1998) reported significantly ($P< 0.01$) higher respiration rate and rectal temperature in control group of buffaloes when compared to buffaloes, splashed water three times a day,

Das *et al.*, (1999) reported increase in respiration rate, pulse rate, rectal temperature and skin temperature in young buffaloes exposed to solar radiation and recommended protection from direct solar radiation for young animals.

2.2 FEED INTAKE AND GROWTH

The primary aim of feed intake in any living being is to maintain the body temperature, which is required to carry on the essential life supporting activities. Since the microclimate directly effects the comfort/stress level of the animal it will have direct effect on the feed intake, growth and production levels in the animals.

In a thermoneutral environment, voluntary feed intake of animals does not vary with change in temperature but higher temperature it is reduced and is lower temperatures it is increased (Ragsdale *et al.*, 1948, Mullick, 1949)

Environmental temperature has direct effect on animal energy expenditure and voluntary feed intake. Animals maintain the body warmth by regular feed intake, but under thermal stress reduces feed intake to prevent hyperthermia. (Brobeck, 1960)

Thomas (1969) concluded that the unsheltered animals consumed more dry matter and TDN than sheltered ones. If animals are experiencing cold stress under less protected conditions, they would increase the heat production to maintain homeothermy with a consequent increase in feed consumption.

According to Tripathi *et al.*, (1972) studied the effect of shelter and sprinkling of water during summer on weekly gain in body weight and other body measurements of growing Murrah heifers between 0-18 months of age and recorded faster gain in body weight (15 %) and length (30%) in comparison to controls.

According to Pontiff *et al.,* (1974) feed intake during winter was reduced with a provision of wind breaks.

Bartes and Forbes (1974) summarized that there is a direct negative effect on appetite center due to elevated body temperature.

Rusev (1976) reported consumption of feed units/kg gain for loose barn, semi- loose barn, and paddock as 4.96, 4.82, 4.59 during winter and 6.11, 5.85, 5.61 during spring and 9.71, 10.41, 9.30 during summer respectively.

Konggard in (1977) reported in a four-year study, better-feed conversion efficiency in bedded loose housing system for cows.

According to Leu *et al.,* (1977) cattle with shelter tended to convert the feed more efficiently .

Jadhav (1979) found that dry matter intake in crossbred cows was less in closed housing as compared to loose housing in winter season.

Bose and Thomas (1979) showed better growth response when individual pens were provided to the buffalo calves with in a large shade with high roof. The pens were provided with dung and slaked lime bedding in winter but no special bedding in summer.

Patel (1981) observed the average dry matter intake/kg body wt. Gain for sheltered and exposed crossbred male calves vs. Kankrege heifers as 7.26 and 8.72 vs.12.29 and 18.44kg respectively the mean consumption being higher for sheltered group.

Sastry *et al.,* (1981) reported 16% higher weekly gains in live weight in young buffalo heifers by providing additional shelter and sprinkling of water.

Kovalcik and Broucek (1982) reported significantly higher feed consumption in heifers of 13-19 months housed loose than in cubicles.

Barua *et al.,* (1982) reported that in tropical climate, dairy farm should be as open as possible but temporary barriers are required during inclement weather like extreme cold and hot.

Karki *et al.,* (1983) studied the effect of three housing systems viz (A) calves tethered in a shed during day and in the open during night, (B) tethered inside shed throughout and (C) kept loose in loose house throughout hot

humid season. They found the highest daily weight gain in group C (550 g) followed by group B (455 g) respectively.

Shijimaya *et al.*, (1985) concluded that there was no significant increase in dry matter, TDN and net energy intake in dairy animals exposed to cold, though it was higher for cold exposed animals.

Ostergaard *et al.*, (1989) reported that feed conversion efficiency is not affected irrespective of housing type that is loose housing or stall.

Wiersma and Armstrong (1989) found that in hot arid region evaporatively cooled shade reduce the level of stress during rest periods. Shade and/or misters of the feed manger be used to encourage cattle to eat at hottest part of day.

Korsun (1993) found that feed consumption decreased for all cows when air temperature increased above 24^0C. Feed consumption of animals under shade conditions were on an average of 9% higher than those of without shade.

Campos *et al.*, (1993) reported significantly higher average daily gain in Holstein calves housed in conventional brick building during summer than calves in open shelter.

According to Fulsoundar and Radadia (1993) daily body cooling by splashing of water at 10 minutes interval during 12.30 to 14.30 hrs significantly increased dry matter intake and decreased water intakes in Kankrej cows.

According to Muller *et al.*, (1994) feed intake of shaded cows was higher than that of unshaded cows.

Ahmed and Amin (1997) reported that the feed intake in Holstein Freisian and Boran cows was decreased by 0.24 and 0.06g/kg/hr respectively for every 1^0C increase in ambient temperature.

2.3 HAEMATOLOGICAL PARAMETERS

Blood fulfills a number of functions in the body and any alterations in the constituents of the blood reflects the current functional status of the system.

Mansera *et al.*, (1940) indicated that blood constituents could be used as an index for assessing the adaptability of cattle to climate.

Mullick and Kehar (1952, 1959) found seasonal variations in haemoglobin level in Kumauru steers, Sahiwal x Hariana and Deoni x Hariana crossbreds and purebreds Harian cows.

According to Razdan *et al.*, (1969) haemoglobin level was regulated by changing environmental conditions, Hb, PCV, RBC counts have got a negative correlation with atmospheric temperature. They further reported that exposure of animals to solar radiation would aggravate the thermal stress resulting in a greater change in PCV.

Decreased appetite in calves having haemoglobin less than 07.0 g/dl was reported by Bremner *et al.*, (1976).

Gwazdauskas *et al.*, (1980) indicated that total and differential circulating leukocyte counts may be responsive to chronic stress in cattle.

Dantzer er al (1983) compared cortisol concentration after an ACTH challenge of calves group housed on straw bedding and those tethered on slatted floors., greater response of cortisol in the individually housed calves than in the other calves.

In an experiment conducted by Winters *et al.*, (1984) reported that cortisol level could be used as an indicator of stress.

Friend *et al.*, (1985) reported higher basal cortisol level, thyroid hormone levels and N:L ratio in stressed calves.

Friend and Dellmeier (1986) studied young calves under different housing conditions and concluded that neutrophils tended to elevated and lymphocytes lowered in stalls than those compared with house animals in loose house system.

Reece and Hotchkiss (1987) reported higher RBC, PCV, Hb concentration in calves, which were freely housed than those calves, whose movement was restricted.

Stull and McMartin (1992) concluded that neutrophils to Lymphocyte (N: L) ratio greater than the range of 0.35 to 1.15 were indicative of stress.

According to Adams *et al.*, (1992) there was lower WBC count for healthy calves when compared to diseased.

Wilson *et al.*, (1994) conducted studies on veal calves and reported that there is significant positive correlation between erythrocyte concentration,

haemoglobin and average daily weight gain (ADG). Mean total leukocyte concentration has negative correlation with ADG.

Stull and McDonough (1994) reported that N: L ratio is a better indicator of stress than cortisol level.

Wilson *et al.*, (1999) opinioned after going through various literature and observed that physiological measurements of stress include neutrophils: lymphocyte ratios, white blood cell counts, cortisol, and acute phase protein.

2.4 CORTISOL LEVELS

Cortisol being a metabolic hormone has found to have wide ranging activities. Immediately after birth it helps the animal in adapting to the environmental conditions and plays an important role in energy metabolism in neonates by modulating the thyroid and hypothalamus thus ensuring better survivability. In neonates there is high level of blood cortisol when compared to adults but this decreases progressively over first two to three weeks of post natal life. (Jost and Picon, 1970; Nathanielsz 1976; Hudson *et al.*, 1976)

During heat acclimation there is reduction of plasma cortisol that help the animal in reducing the heat production (Yousef and Johnson 1967). The same is reported by Stott and Wiersma (1971).

Stott and Robinson (1970) Alvarez and Johnson (1973) and Johnson and Uanjonack (1975) observed that there was an initial increase in hormone due to acute heat stress which was followed by a decline after prolonged exposure to stressor.

Stott and Wiersma (1971), suggested that animals were able to adjust physiologically to elevated heat loads by decreasing adrenal corticoid output.

Christison andd Johnson (1972) observed that the short term response of cortisol to heat stress was part of an acute non-specific reaction which could be exhibited in response to a wide variety of stressors.

Trenkle and Topel (1978) studied cortisol level in Charolais steers and reported cortisol levels of 3.6, 2.4, 2.3, 2.2 ng/ml on 145, 303 389 and 520 days respectively. There was significant correlation between plasma corticosteroid level and age. The same authors, based on their study on two beef breeds reported decrease in plasma cortisol level with increasing body weight. The correlation between the plasma cortisol level and body weight

was not significant but there was highly significant correlation between plasma levels of cortisol and average daily gain of body weight.

Neuwirth *et al.*, (1979). Observed that male Holster calves (3-4 weeks old) responded with increased cortisol level only about 32.2^{0}C and 60% RH.

Ingram *et al.*, (1979) reported a decline in cortisol concentration upon exposure to hot environment.

According to Purchas *et al.*, (1980) there was positive correlation between plasma cortisol level and growth rate in Angus steers. But in case of Hereford steers the correlation was negative, signifying the breed effect.

Henricks *et al.*,. (1984) reported no significant correlation between cortisol levels in plasma and age.

Gettys *et al.*, (1988) reported that mean serum levels of in bulls were 22, 22, 24, 26, 17, 19 and 14 ng/ml during 10 through 16 months of age, respectively.

Glucocorticoids affect carbohydrate, protein and lipid metabolism. In liver they have got anabolic action but in skeletal muscles and adipose tissue they have got catabolic activity. They organize the function of the sympatho-adrenal system, which helps in managing stress conditions. (Hadley, 1988).

Cortisol secretion is regulated by hormonal interactions among the hypothalamus, the pituitary, and the adrenal gland. Neural stimuli originate from brain in response to stress. Physical stress can include exercise, cold exposure, burns etc (Orth *et al.*, 1992)

Henricks *et al.*,. (1994) observed effect of feeding levels on growth rate and plasma cortisol level but there was no significant difference in basal or peak concentration of cortisol and number of cortisol peaks in different feeding levels and different growth rates.

Bag (2000) concluded that cortisol levels in plasma were negatively correlated to the body weight and fast growing animals had lower levels of plasma whereas slow growing animals had higher levels.

2.5 HOUSING CONDITIONS

The ultimate role of any housing system is to modify the microclimate in a manner, which is suitable or beneficial to the animal. The most important factors affects by the housing systems are minimum and maximum temperature, relative humidity, wind velocity, temperature humidity index etc.

Satyapal *et al.*, (1973) found the asbestos roofed loose house produced a moderate microclimate than open.

Karki, (1981), Mehta, (1982) and Singh, (1982) reported higher humidity percent in hot seasons in loose house than in shed, whereas in cold season the humidity was similar.

The meteorological factors of external environment and the construction itself affects the conditions inside the animal houses (Padmanabhamurthy, 1983)

Bempong (1983) compared the shade with loose house and found that the THI in open and loose house was similar giving an indication that thermal load on animal under two conditions may not be varying different in hot humid summer.

The macroclimate-microclimate relationships are different in different seasons as reported Singh *et al.*, (1984). The THI indicated that loose house was more stressful during day time in summer.

Singh *et al.*, (1985) compared the microclimatic variables inside a brick- walled, asbestos- roofed shed and in a loose house and reported that, compared to the levels in the open, the levels inside shed and loose house of minimum temperature were 2.5 – 3.5^{0}C and 1.5 – 2.5^{0}C higher: the daily maximum temperature was 0.5 – 9.8^{0}C lower and 0.5 – 1.6^{0}C higher and the vapor pressure were 3 and 5mm Hg higher respectively.

Thiagarajan and Thomas (1992) studied the effect of housing on lactating cows in hot-humid area and reported heart rate and skin temperature were significantly higher in the exposed cows than protected cows. There was a significant negative effect on solar radiation on heart rate in unsheltered cows. The wind velocity was negatively correlated with respiration rate, rectal and skin temperature and positively correlated with heart rate.

Armstrong (1994) reported that the decrease in milk production and reproductive efficiency in heat stress is offset by implementation of a program consisting of cooling through shades, ventilation, sprays and fans.

Niles *et al.*, (1994) reported that loose sand bedding had an overall positive effect on cow comfort.

Patel *et al.*, (1995) studied three different housing systems; concrete shed, thatched roof shed, and three shelters for buffalo heifers and reported that minimum temperature was significantly affected by the housing conditions. But maximum temperature, relative humidity and temperature humidity index (THI) did not differ significantly among housing conditions. Body weight gain and feed intake per kg body weight were not significantly among housing conditions. Body weight at different ages and feed conversion efficiency had overall positive correlation with microclimatic variables except THI whereas weight gain had overall negative correlation with micro climatic variables except THI.

From the literature available, it is clear that no study was conducted to understand the beneficial effect of providing maximum comfortable microclimate to the animals, throughout the 24 hr with monitoring both haematological and physiological parameters; hence the present study was undertaken

CHAPTER - 3

MATERIALS AND METHODS

3 MATERIALS AND METHODS

The present study was conducted to observe the effect of modified housing on the physiology of growing crossbred males.

3.1 Location and duration of study.

The study was conducted at the Artificial Breeding Complex of NDRI Karnal. Karnal is located 250 m above mean sea level 29.42' North latitude and 79.54' longitude. Average rainfall is about 700 mm, which mostly fall on the monsoon in July- September. Study period was for four months, from February to May.

3.2 Selection of the animals.

Two groups of animals were selected; each consists of 5 growing KF males. Animals were selected in such a way that each group is identical in maximum possible ways.

3.3 Feeding of the animals.

Animals were fed 2 kg standard concentrate at morning as the first feed of the day. High quality green fodder like berseem oat, maize, jower was fed *ad libitum* depending upon the availability of fodders. During lean season silage was also fed *ad libitum*. Water was available round the clock.

3.4 Treatment

Group I was housed under modified housing conditions. The modifications are mentioned below.

During first two months animals were protected from cold and chilly wind during night with wind screens and animals were given bedding of jower straw. During daytime they were kept with direct access to sunshine. During April and May extra protection was given during daytime. Animals were protected from direct sunshine and hot wind using screens made of gunny bags. During peak hot hours they were given cold water shower. The screens

kept wet throughout the daytime. Bedding of fine sand provided to give comfort to the animals in the hot climate. The screens were removed during nighttime so that the animals were allowed to be in the comparatively comfortable conditions.

The group II, which also consisted of similar five animals, were treated as control were housed under existing conditions at Artificial Breeding Complex. Animals were kept in semi-covered area with half walls and animals were exposed to cement-concrete floor throughout the experimental period. The animals were fed *ad libitum* same feed as in group I and water was provided during 24 hours of the day.

The whole period of experiment was divided into two (Feb-Mar comprised period I and April-May comprised period II) to compare the beneficial effect of two treatments in two separate climatic conditions. The first seven weeks comprised the period I and the next seven weeks comprised period II.

3.4.1 Details of the experimental calves.

Table3.1 Details of Experimental Group

Sr. No	Date of Birth	Initial Body Weight (kg)
1	09-01-2000	125
2	10-02-2000	110
3	19-03-2000	100
4	21-04-2000	150
5	04-07-2000	150

Table 3.2 Details of control group

Sr. No	Date of Birth	Initial Body Weight (kg)
6	14-01-2001	120
7	25-02-2000	105
8	02-03-2000	110
9	27-04-2000	115
10	31-07-2000	110

3.5 PARAMETERS OBSERVED

3.5.1 Physiological parameters.

The following parameters were observed at 0630 hr and 1430 hr twice a week.

3.5.1.1 Respiration rate

Respiration rate was taken from flank movements per minute, one inside and one outside movement was recorded as one beat per minute (bpm)

3.5.1.2 Heart rate

Heart rate observed by auscultation with the help of stethoscope, and recorded as beats per minute (bpm)

3.5.1.3 Rectal temperature

Rectal temperature was recorded using a digital clinical thermometer.

3.5.1.4 Skin temperature

Skin temperature was taken using a tele-thermometer. Two readings were taken one from the skin of the side of the neck and the other on the rump region and the average value was taken.

3.5.2 Haematological Parameters

Blood samples were collected from jugular vein using EDTA (disodium salt) as anticoagulant at the dose of 1mg/ml in weekly interval. The following haematological parameters were carried out in whole blood.

3.5.2.1 **Erythrocyte concentration: -** estimated using a neubar chamber.

The procedure is given in detail below: -

(a) Drew the blood exactly to the 0.5 mark of the erythrocyte diluting pipette.

(b) The tip of the pipette wiped free of blood.

(c) Then Gower's solution drawn into the pipette with steady suction to the mark '101' above the bulb, rotating the pipette gently while filling.

(d) Pipette was shaken for 3 minutes with both ends closed with fingertips.

(e) After mixing properly, the neubar counting chamber covered with a cover slip was charged with the diluted blood (dilution 1:200).

(f) Allowed few minutes for the cells to settle.

(g) Then cells in five small squares were counted.

(h) The concentration of RBC was calculated by multiplying the sum of cells in five small squares by 10,000.

Composition of Gower's Solution

Table 3.3

Sodium Sulphate	12.5 gm
Glacial Acetic Acid	33.3 ml
Distilled Water	200.0 ml

3.5.2.2 **Total Leucocyte Count: -**

TLC was estimated using a neubar chamber.

The procedure is given in detail below.

Counting of leucocytes :-

(a) Drew the blood up to 0.5 mark of WBC pipette

(b) Wiped blood from the tip.

(c) Diluting fluid was then drawn up to the '11' mark above the blood.

(d) Shook for 3 minutes

(e) Then charged the neubar chamber.

(f) Allowed 1 minute for the cells to settle.

(g) Cells were counted under low power in each of the 4 large corner squares.

(h) The concentration was calculated by multiplying the sum of the cells in 4 large squares with 50.

WBC Diluting Fluid Composition

Table 3.4

Glacial acetic acid	2 ml
Gentian violet	1% aqueous 1 ml
Distilled water	100 ml

3.5.2.3 **Packed Cell Volume**

PCV was estimated using Wintrobe tubes by centrifuging for 30 minutes at 3000 rpm

3.5.2.4 **Hemoglobin Concentration**

Hemoglobin concentration was estimated by using the acid haematin method

3.5.2.5 **Differential leukocyte** count

Differential leucocyte counted was observed from a smear made on microscopic slide from a drop of blood collected from ear tip and stained using Wright's stain and differential count was taken under oil immersion microscope.

3.5.3 Plasma Cortisol Estimation

To estimate the plasma cortisol level one ml of plasma was taken from each sample of blood collected. Blood was centrifuged for 30 min at 3000 rpm and kept in 2ml storage vials at- 20^0C. At the end of the experiment, all the plasma samples were analyzed for cortisol level by direct Radio Immuno Assay, the procedure of which is detailed below.

Radio Immuno Assay for Cortisol.

Cortisol in blood plasma was quantified by using a direct radioimmuno assay technique described by Sujata (1987). 50 µl of plasma aliqots were pepetted in duplicate in 10x75 mm tubes, to which 350 µl 0.02 M PBS (pH 7.3) was added. The contents of the tubes were mixed properly and incubated at 70°C for 30 minutes in a hot air oven for denaturation of cortisol binding proteins. The tubes were cooled down to room temperature.100 µl of diluted antisera was added to each tube and then 100 µl labeled tracer containing approximately 10,000 CPM. All the tubes were gently shaken to mix up the reagents and incubated at 4°C overnight. Following incubation, 500 µl of cold dextran coated charcoal (0.625% activated charcoal and 0.0625% Dextran T-70 in PBS) was added to each tube. The tubes were gently shaken and incubated in ice water for 15 min. Then the tubes were centrifuged for 15 min at 3000 rpm at 4°C. Then the supernatent was decanted directly into scintillation vials and then 5ml of scintillation fluid (0.10 g POPOP and 4 g PPO in 1 litre toluene) was added. The resulting mixture was incubated at 4°C overnight and Beckman Liquid Scintillation Counter counted radioactivity. Along with the assay, standard tubes in triplicate containing cortisol standard ranging from 9.5 pg to 10 ng per 100 µl of PBS were taken. These were processed identically as plasma samples.

(a) Blank tubes, in triplicate, containing 500 µl of tracer to observe the nonspecific binding of charcoal separation procedure.

(b) Four tubes containing 400 µl of PBS, 100 µl of cortisol antisera and 100 µl of tracer to obtain buffer maximum binding of tracer by antibody.

(c) Two tubes containing 100 µl tracer diluted to 1000 µl with PBS mixed and decanted directly into the scintillation vials.

(d) Recovery tubes with known amount of hormone added to 50 µl of plasma and processed identically as plasma samples.

(e) Two different pooled plasma samples were run after every 40 tubes which were identically processed as unknown plasma samples for determining intra and interassay coefficient of variation.

3.5.4 Dry Matter Intake

Dry matter intake was recorded at monthly interval. The dry matter intake separately through concentrate and green fodder was taken and total DMI was calculated for individual animal.

3.5.5 Body Measurements

Body measurements were taken at monthly intervals. Heart girth was recorded using measuring tape, around the chest just behind the elbow. Body length was recorded from point of shoulder to pin bone. Height at withers was recorded as height of the animal.

3.5.6 Climatological observations

The daily maximum and minimum temperature, Relative Humidity, wind speed, etc. was recorded during the entire period of study.

3.6 Statistical Analysis

The data were analyzed statistically as per Snedecor and Cochran (1968) by using statistical models.

CHAPTER - 4

RESULTS AND DISCUSSION

4. Results and Discussion

Modified housing system was compared with already existing housing for providing better conditions to the animals and thus to ensure better production performance. The response of the animals were observed through the difference in various physiological parameters like respiration rate, heart rate, rectal temperature, skin temperature, haematological parameters like PCV, Hb, RBC concentration, TLC, percentage of different leucocytes and plasma cortisol level, dry matter intake, increase in body weight, and body dimensions under two housing condition. Their interrelationship among different parameters were analysed and prevailing climatic condition were monitored during the experiment. The results for different parameters have been presented in Tables 4.1 to 4.18 and fig. 4.1 to 4.10.

Mean monthly values of climatological variable are presented in table 4.1.

4.1 Physiological Responses

The results of different physiological parameters and their statistical analysis have been presented in Tables 4.2-4.7, and 4.11-4.12 and fig. 4.1 to 4.4. During the present study, the physiological reaction was found to be higher under group II as compared to group I (Table 4.2 to 4.6).

4.1.1 Respiration Rate

The overall mean values of Respiration Rate for group I at morning was 31.69 $\pm$ 0.46 bpm (range 26 to 36) and during evening it was ranging from 38 to 54 with the mean value of 46.0 $\pm$ 0.41 bpm. The corresponding values for group II were 33.16 $\pm$ 0.28 and 47.19 $\pm$ 0.52 bpm respectively (Table 4.4). The higher respiration rate in the experimental animals during morning hours may be due to the young age of the animals.

Lal *et al.*, (1987) and Mishra *et al.*, (1995) have also reported higher respiration rate in afternoon than morning values in Haryana cows and crossbred heifers respectively.

Table 4.1: Monthly means of climatological variables for the experimental duration.

Months	Temperature (%)						Relative Humidity (%)		Wind Speed (Km/hr)	THI
	Dry Bulb		Wet Bulb							
	I	II	I	II	Max.	Min.	I	II		
February	9.8± 0.63	23.3± 0.45	8.9± 0.60	16.2± 0.43	23.8± 0.45	07.1± 0.2	88± 1.68	44± 1.36	2.8	64.18±0.99
March	15.9± 0.56	27.3± 0.41	8.9± 0.48	19.2± 0.36	28.0± 20.2	11.5± 0.57	80± 1.93	43± 1.72	3.2	68.33±1.01
April	24.0± 0.69	34.3± 0.73	14.0± 0.73	20.7± 0.70	34.8± 1.1	17.5± 0.9	58± 2.1	28± 2.2	4.3	75.25±0.98
May	26.8± 0.71	36.4± 0.74	18.4± 0.76	24.23± 0.68	37.5± 0.97	23.2± 0.91	62.7± 2.2	37.1± 2.4	8.14	78.85±1.02

I – Morning value **II – Afternoon value**

During the first period of experiment (February-March), the mean respiration rate for group I was found to be 29.31 ± 0.63 bpm in the morning and 45.00 ± 0.03 during afternoons. The respective values for group II were 32.31 ± 0.68 and 46.55 ± 0.72bpm respectively (Table 4.2). Patel and Dave (1988) reported a mean respiration rate of 36.65 for Holstein, Kankrej crossbred calves during hot dry climate.

During the second period group I had a mean respiration rate of 34.05 ± 0.37 bpm in morning and in evening the value was 46.9 ± 0.67. For group II the values were 34.0 ±0.78 and 47.81 ± 0.81 bpm respectively (Table 4.3).

Similar trend of higher respiration rate during hottest part of the year has also been reported by Lal *et al.*, (1987), Patel and Dave (1988) and Mishra *et al.*, (1995) in Haryana and crossbred calves and crossbred cows respectively.

Analysis of variance revealed that there was significant difference ($p<0.01$) between two groups and between two periods of experiment (Table 4.7). In these animals RR has been observed to be physiologically compensated resulting in increase with increased ambient temperature and decrease with decreased ambient temperature. These changes were primarily to compensate the heat, due to changed environmental temperature and metabolism. Similar higher significant values of respiration during afternoons and in exposed crossbred cows have been reported by Thiagarajan and Thomas (1992).

Parihar *et al.*, (1992) also reported significant difference ($p<0.05$) in respiration rate between calves in shed and open.

Respiration rate had got positive correlation with THI (Table 4.11 and 4.12). Patel and Dave (1988) reported similar positive correlation between respiration rate and THI in calves of Jersery X Kankrej and Holstern-freisian X Kankrej corsses.

4.1.2 Heart Rate

Mean values of heart rate during morning for the experimental period remained slightly higher in group II than group I. The values being 64.37 + 0.51 bpm (morning) and 77.41 + 0.58 bpm (evening) for group II against 61.57 +0.55 (morning) and 76.97 + 0.39 (evening) of group I. These values

are presented in Table 4.4. These results are in accordance those of Thiagarajan and Thomas (1997) in crossbred cows. They reported higher cardiac rate in exposed cows as compared to shaded.

Mean values of heart rate during morning for experimental group I in the first period was 58.99 ± 0.84 bpm and during evening it was 75.01 ± 0.59 bpm. The respective values for control group were 62.60 ± 0.59 bpm and 75.82 ± 1.05 (Table 4.2). During second period mean value of heart rate for group I at morning and evening were 64.16 ± 0.59 and 78.9 ± 0.39 bpm respectively and the respective values for group II were 66.14 ± 6.53 and 79.0 ± 0.42 respectively (Table 4.3).

The higher values of heart rate during period II in group I and II indicates the positive effect of environmental temperature on heart rate. The correlation coefficient was more for group I (0.483) as compared to group II (0.34), both values were being significant at 1% level. These results are in accordance with those reported by Thiagarajan and Thomas (1992) in crossbred cattle.

Analysis of variance showed significant difference ($p<0.01$) in heart rate between two groups and between two periods (Table 4.7). Mullick and Kehar (1952) had also reported an increase in pulse rate with the rise of environmental temperature. Thiagarajan and Thomas (1992) reported a negative and significant ($p<0.05$) effect of solar radiation on the cardiac rate.

4.1.3 Rectal Temperature

During the whole experimental duration the mean morning value of rectal temperature for group I and group II were 37.97 ± 0.02 and 37.95 ± 0.02°C respectively and the respective values for evening were 38.84 ± 0.02 and 38.91 ± 0.03°C respectively. The range of morning value of rectal temperature was 37.33 to 38.27°C and the range for evening values was 38.72 to 39.28°C (Table 4.4). Gaughan *et al.*, (1999) also reported the daily variation in rectal temperature of 0.7° and 1.7°C under thermoneutral and hot environmental conditions respectively in Hereford steers.

Rectal temperature showed a mean value of 37.87 ± 0.03°C during morning hrs for first period in group I and in control group the value of rectal temperature was 37.81 ± 0.03°C.

During evening hrs mean values of rectal temperature were 38.73 ± 0.04°C and 38.78 ± 0.02°C in group I and group II respectively (Table 4.2). During 2nd period mean morning rectal temperature for group I and group II were 38.07 ± 0.02 and 38.09 ± 0.03°C respectively. During evening hrs, the respective mean values were 38.97 ± 0.03 for group I and 39.03 + 0.03°C for group II, showing considerably higher values in control group (Table 4.3). Lal *et al.*, (1987) also reported higher rectal temperature in Haryana cattle during hotler part of the year.

Analysis of variance revealed no significant difference between two groups, but there was significant difference between two periods of experiment which was on expected due to the change in THI and higher ambient temperature in the second period (Table 4.7).

Rectal temperature had higher positive correlation with THI in control group than experimental group 0.51 Vs 0.16 (Table 4.11) indicating that control group was more susceptible to the variations in the THI. The rectal temperature of animal has been considered as an index of heat storage depending upon the thermolytic and thermogenic processes taking place simultaneously at a particular climate conditons. The cold water shower given to the group I during hot period of the day may had beneficial effect for reducing the rectal temperature. Gangwar *et al.*, (1980) reported a decrease of 0.8°C of evening rectal temperature in hot dry climate by spray cooling.

4.1.4 Skin Temperature

The overall mean morning skin temperature (ST) was slightly higher in group II (28.28 ± 0.34°C) than that of group I (28.11 ± 0.36°C). The respective values for evening were 36.58 ± 0.18 and 35.97 ± 0.23°C respectively (Table 4.4).

Thiagarajan and Thomas (1992) reported lower values of ST under shaded (37.64°C) than unshaded (38.56°C) conditions in crossbred cows during hot humid season.

Mean values of skin temperature (ST) during morning hrs of period I were 24.87 ± 0.34°C and 25.12 ± 0.34°C from group I and group II respectively. The ST during evening for the same period were 34.63 ± 0.38°C

Table 4.2: Mean ± S.E. of different Physiological Parameters of crossbred males under two housing conditions for period I.

Physiological parameters	Observation time	No. of Observations	Group I	Group II
Respiration Rate (bpm)	M	70	29.31±0.63	32.31±0.41
	E	70	45.14±0.62	46.55±0.68
Heart Rate (bpm)	M	70	58.99±0.84	62.60±0.83
	E	70	75.09±0.59	75.83±1.05
Rectal Temperature (°C)	M	70	37.87±0.03	37.81±0.04
	E	70	38.73±0.04	38.78±0.02
Skin Temperature (°C)	M	70	24.87±0.34	25.12±0.34
	E	70	34.63±0.38	35.75±0.32

M-Morning, **E-Evening** **THI, Morning – 60.1 ± 0.74, Evening – 69.8 ± 0.64**

Table 4.3: Mean ± S.E. of different Physiological Parameters of crossbred males under two housing conditions for period II.

Physiological parameters	Observation time	No. of Observations	Group I	Group II
Respiration Rate (bpm)	M	70	34.05±0.37	34.0±0.035
	E	70	46.9±0.67	47.81±0.78
Heart Rate (bpm)	M	70	64.16±0.59	66.14±0.54
	E	70	78.9±0.39	79.0±0.42
Rectal Temperature (°C)	M	70	38.07±0.02	38.09±0.03
	E	70	38.97±0.03	39.03±0.03
Skin Temperature (°C)	M	70	31.34±0.34	31.44±0.30
	E	70	37.34±0.06	37.4±0.08

M-Morning, E-Evening THI Morning-71.9 ± 0.69, Evening-81.4 ± 0.61

Table 4.4: **Mean ± S.E. of different Physiological Parameters of crossbred males under two housing conditions for overall duration of study.**

Physiological parameters	Observation time	No. of Observations	Group I	Group II
Respiration Rate (bpm)	**M**	140	31.69±0.46	33.16±0.28
	E	140	46.0±0.41	47.19±0.52
Heart Rate (bpm)	M	140	61.57±0.55	64.37±0.52
	E	140	76.99±0.39	77.41±0.58
Rectal Temperature (°C)	**M**	140	37.97±0.02	37.95±0.03
	E	140	38.84±0.02	38.91±0.02
Skin Temperature (°C)	M	140	28.11±0.36	28.42±0.34
	E	140	35.98±0.23	36.58±0.18

M-Morning, E-Evening **THI Morning - 66.6 ± 0.58, Evening – 75.5 ± 0.7**

Fig. 4.1: **Mean ± S. E. of THI in different periods of experiment.**

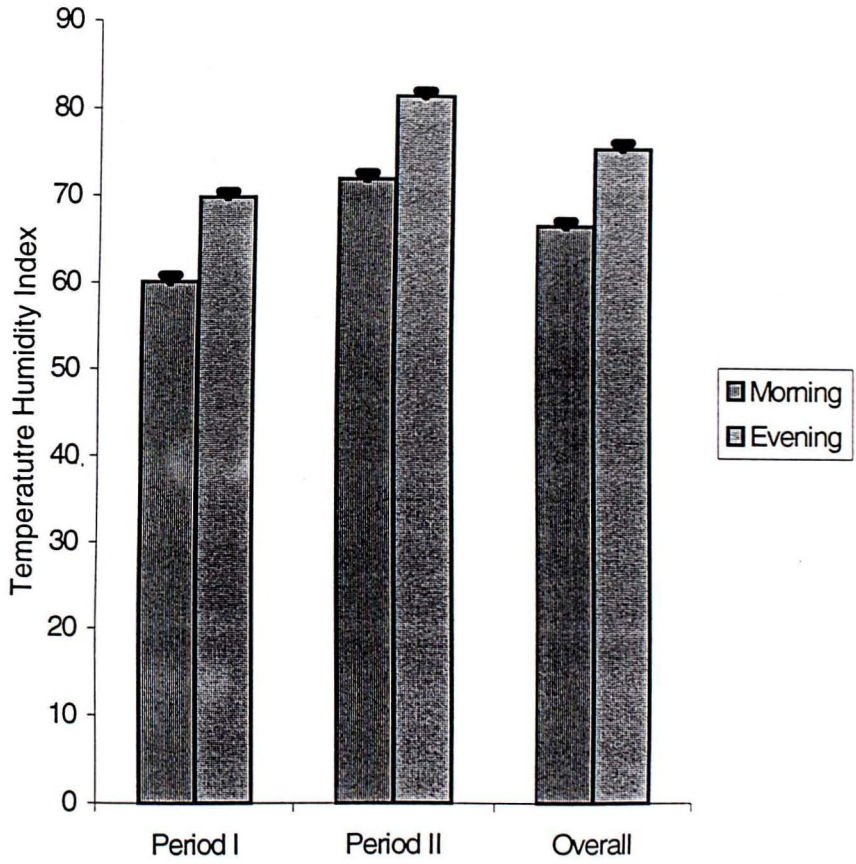


Fig. 4.2: Mean ± S. E. of Respiration Rate for experimental and control group.

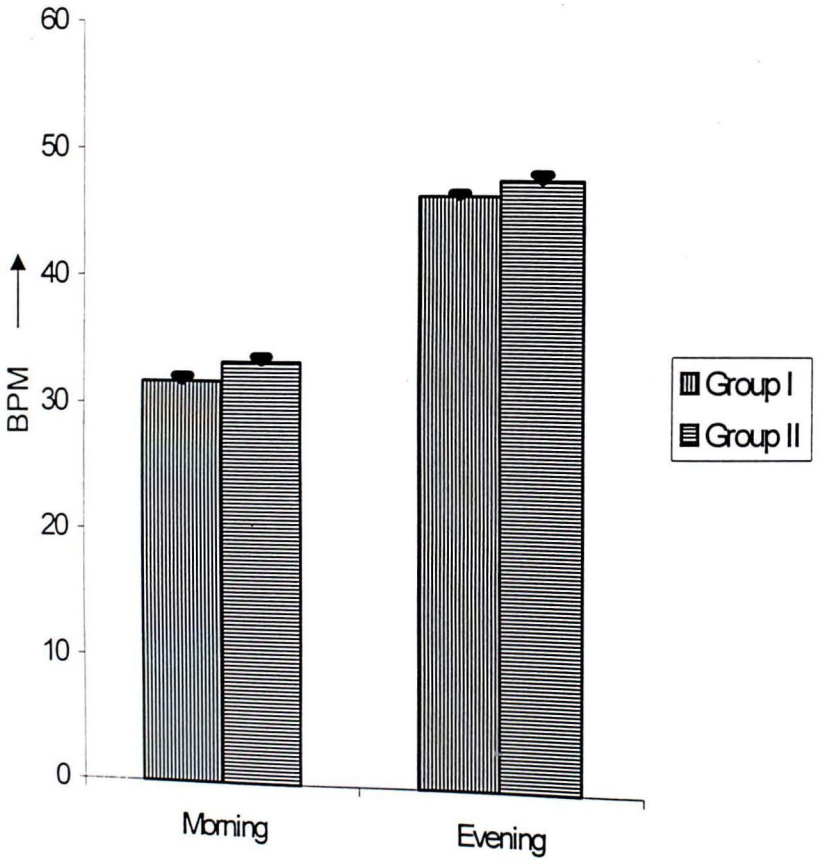


Fig. 4.3: Mean ± S. E. of Heart Rate for experimental and control group.

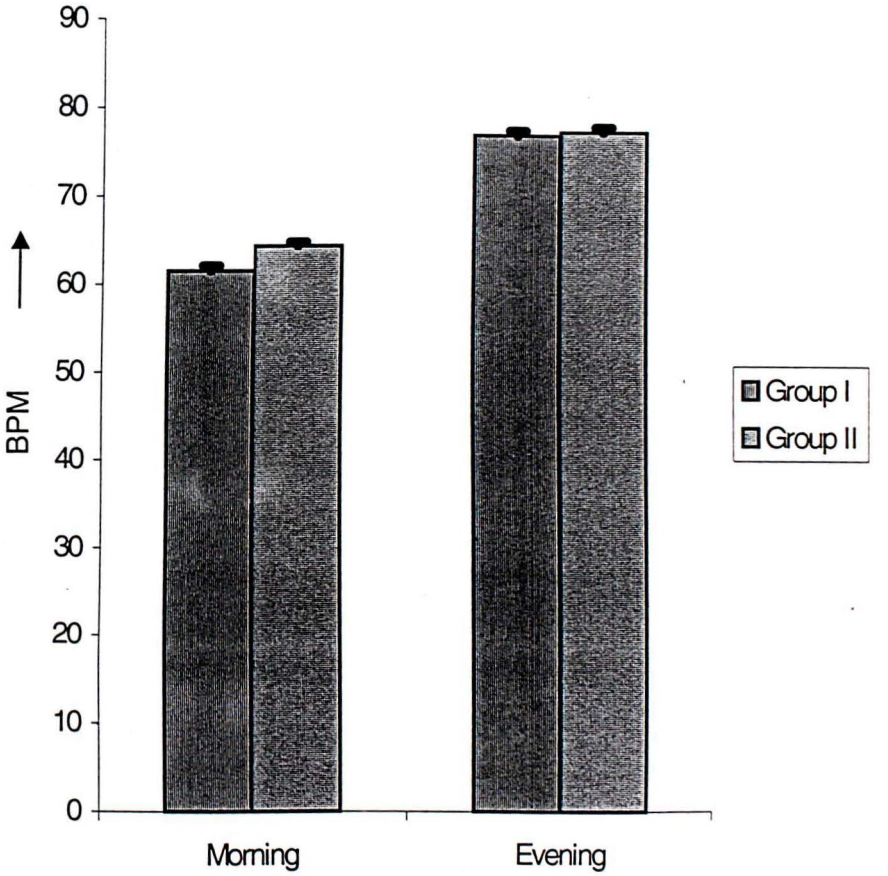


Fig. 4.4: Mean ± S. E. of Rectal temperature for experimental and control group.

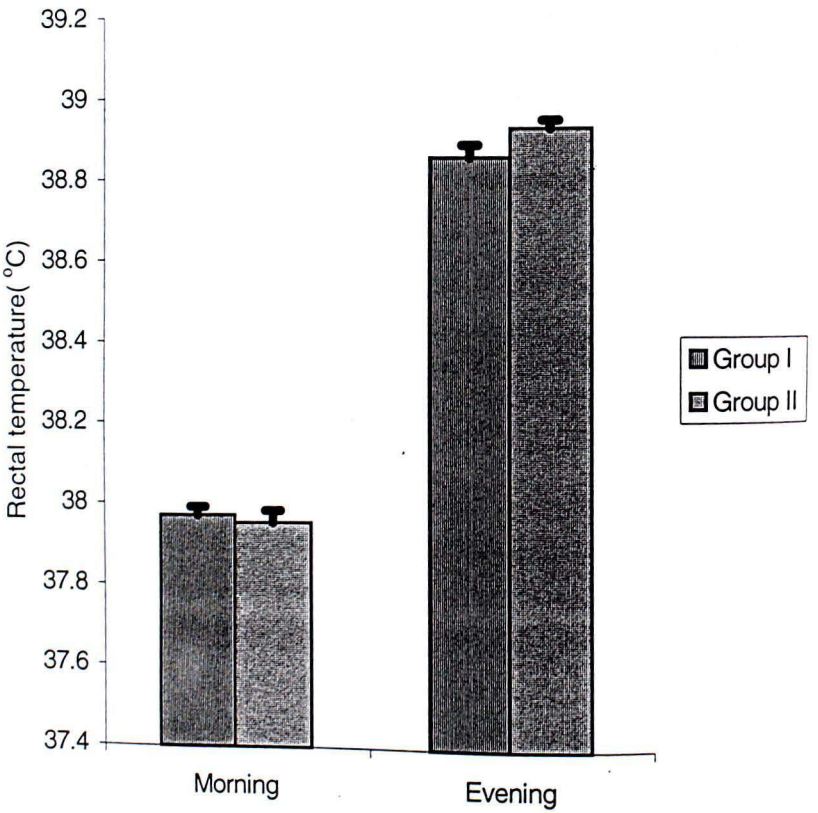


Fig. 4.5: Mean ± S. E. of Skin temperature for experimental and control group.

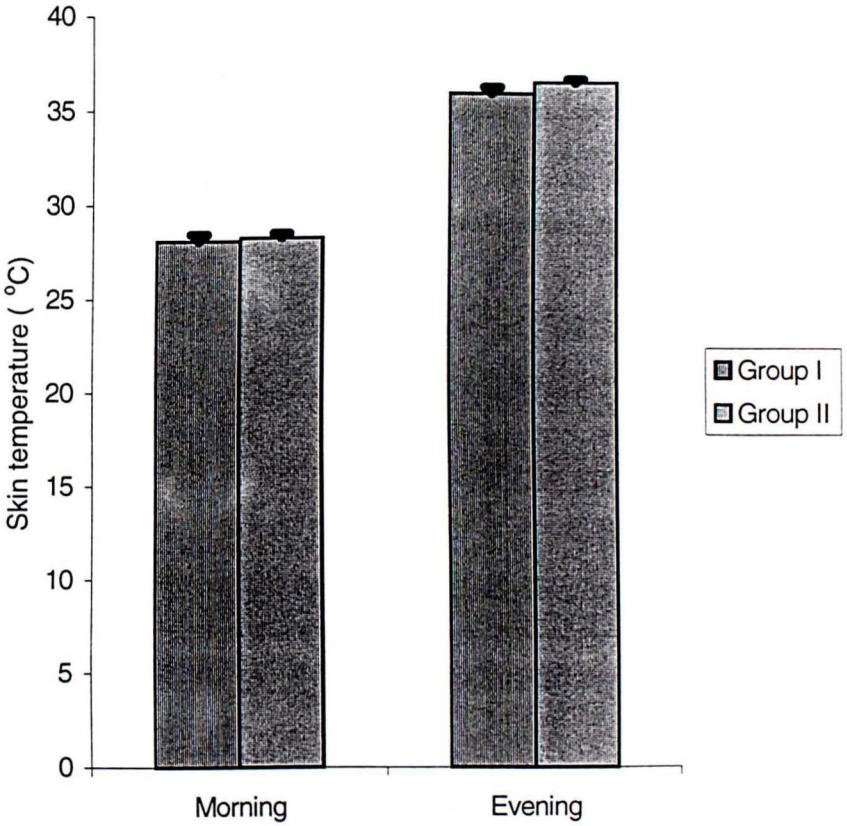


Table 4.5: Mean ± S.E. of different physiological parameters of individual animals of group I.

Animal No.	Period	Interval	No. of Observation	Respiration	Heart Rate	Rectal temperature	Skin temperature
1	Overall	M	28	28.82±1.10	60.36±1.33	38.0±0.04	28.07±0.79
		E	28	47.71±1.14	76.79±0.62	38.93±0.06	36.20±0.46
2	Overall	M	28	33.04±0.74	61.57±1.28	37.99±0.04	28.92±0.93
		E	28	45.86±0.76	76.79±0.71	38.83±0.05	36.15±0.45
3	Overall	M	28	31.36±0.68	61.32±1.33	37.92±0.06	28.21±0.86
		E	28	45.81±0.87	78.22±0.99	38.91±0.05	36.09±0.46
4	Overall	M	28	32.75±0.88	62.71±1.32	38.01±0.04	28.76±0.86
		E	28	45.50±1.14	75.75±1.16	38.70±0.08	35.67±0.72
5	Overall	M	28	32.46±1.0	61.89±0.95	37.94±0.06	26.56±0.53
		E	28	45.14±1.19	77.36±0.74	38.86±0.05	35.75±0.41

Table 4.6: Mean ± S.E. of different physiological parameters of individual animals of group II.

Animal No.	Period	Interval	No. of Observation	Respiration	Heart Rate	Rectal temperature	Skin temperature
6	Overall	M	28	33.14±0.73	65.71±1.09	37.94±0.06	28.48±0.89
		E	28	46.96±1.08	77.71±0.83	38.88±0.051	36.39±0.4561
7	Overall	M	28	32.64±0.63	64.93±1.01	38.02±0.06	28.52±0.727
		E	28	46.78±1.18	78.0±0.59	38.95±0.04	36.68±0.40
8	Overall	M	28	32.93±0.55	64.79±1.25	37.97±0.06	28.09±0.75
		E	28	47.54±1.09	77.43±0.65	38.94±0.05	36.55±0.37
9	Overall	M	28	33.86±0.63	63.29±0.89	37.89±0.06	28.16±0.75
		E	28	47.79±1.20	74.43±2.45	38.88±0.06	36.17±0.38
10	Overall	M	28	33.21±0.59	63.14±1.45	37.93±0.03	28.16±0.75
		E	28	46.86±1.32	79.5±0.83	39.0±0.03	36.55±0.38

Table 4.7: Analysis of variance of different Physiological Parameters under two housing conditions in crossbred males.

Source of Variation	d.f	M. S. S.				
		R. R.	Heart Rate	Rectal Temp.	Skin Temp.	THI
Between intervals	1	28062**	28233**	116.9**	9113.1**	12744**
Between Groups	1	247**	371**	5.86×10^{-2}	22	7.9×10^{-2}
Between Periods	1	786**	2173**	8.5**	2584**	19137**
Interval× Group	1	2.82	192*	0.25*	6.87	0.77
Interval× Periods	1	3.1×10^{-4}	7.6×10^{-5}	1.22×10^{-10}	1.9×10^{-3}	1.7×10^{-8}
Group× Periods	1	56.9	24.23	4.93×10^{-2}	6.97	3.9×10^{-2}
Error	552	24	33	6.6×10^{-2}	5.91	35

**** Significant at 1% level.** *** Significant at 5% leve**

and 35.75 ± 0.32°C for experimental and control groups respectively (Table 4.2).

For the second period, the morning mean values for ST for group I and II were found to be 31.34 ± 0.49 and 31.44 ± 0.30 respectively. The respective values for evening hrs were 37.34 ± 0.06 and 37.41 ± 0.08 respectively (Table 4.3).

The higher values during period II indicate the temperature effect on the rise in ST over the first period. It is a well-known fact the higher environmental temperature had positive relation with increase in ST.

Analysis of variance (Table 4.7) revealed that there was no significant difference between the treatment groups showing no significant effect of housing. ST had positive correlation with TH in both the groups, i.e., 0.78 and 0.81 (significant at 1% level) respectively. ST had got higher positive correlation with respiration rate in group I, (0.511) than group II, (0.29) (Table 4.11 & 4.12). These results are in accordance with the results reported by Thiagarajan and Thomas (1992).

4.2 Haematological Parameters

Mansera *et al.,* (1940) has indicated that blood constituents could be used as an index for assessing adaptability of cattle to tropical climates. Keeping in view the above statement haematological parameters, viz., packed cell volume (PCV), Haemoglobin (Hb), red blood corpuscle (RBC). Total leucocyte count, percentage lymphocytes, neutrophils, eosinophils, and monocytes and plasma cortsol levels were carried out. The ratio of neutrophils to lymphicytes was also calculated. The results for different parameters and their statistical analysis have been presented in Tables from 4.8 to 4.12 and fig. 4.5 to 4.9.

4.2.1 Packed Cell Volume

During the whole period of experiment, group I had a mean value of 34.13 +0.32 for PCV and 34.57 + 0.29% for group II. A lower value of PCV during second season was observable, but there was no significant difference between two groups, the effect was significant between two periods (Table 4.8).

In experimental group the mean value of PCV for the first period was 35.28 ± o.45% and the same value for control groups was 35.82 ± 0.37%. In period II the respective values for group I was 32.97 ± 0.34% for PCV, and for group II was 33.31 ± 0.35% respectively (Table 4.8).

Razdan *et al.*, (1969), also reported almost similar trend between ambient temperature and PCV. In this experiment the correlation coefficient between PCV and THI in the experimental group was –0.30 and in control group it was –0.43. Yousef and Johnson (1964) also reported a significant decrease in cell volume with rising temperature. Hammond *et al.*, (1998) reported that packed cell volume, decreases with increase in ambient temperature.

4.2.2 Haemoglobin (Hb)

The trend showed by the Hb level in the blood by different groups of animals in different groups during different periods were similar to that of PCV levels and the results have been tabulated in Table 4.8 and correlation coefficients in Table 4.11 and 4.12.

The mean value of Hb for group I was 12.65 ± 0.15 g% and for group II was 12.95 ± 0.15 g% for the whole duration of experiment. Similar values have also been reported by Friend *et al.*, (1985) in calves.

The mean values for Hb was 13.31 + 0.20 g% for group I in first period and that of group II was 13.85 ± 0.16 g%. In the second period the group I had a Hb mean of 12.00 ± 0.15 g% and group II had 12.07 ± 0.15 g% (Table 4.8).

The difference was not significant between two treatments (Table 4.10), but there was significant difference ($p<0.01$) between two periods, that is with increase in THI, Hb concentration decreased in both the groups as was revealed by negative correlation coefficient between Hb and THI (Table 4.11 and 4.12) r = –0.34 in group I and r = –0.74 in group II.

Razdan *et al.*, (1969) also reported a similar negative correlation between Hb, concentration and ambient temperature. Mullick and Kehar (1952) have also studied and found seasonal variation in Hb level in different breeds of cattle.

4.2.3 Erythrocyte Concentration

While considering the whole period of experiment the mean value for RBC of group I was 6.22 ± 0.09×10^6/cu mm and for group II it was 6.77 ± 0.09×10^6/cu mm (Table 4.8). This findings were in agreement with Greatorex (1952) who found RBC count ranging from 5.5 – 8.5×10^6/cu mm in calves of same age group.

The mean value of RBC count for group I for the first period was 6.39 ± 0.14×10^6/cu mm. The respectively value for control group was 6.97 ± 0.13×10^6/cu mm. For the second period, group I had 6.06 ± 0.10×10^6/cu mm and for group II the mean was 6.57 ± 0.10×10^6/cu mm (Table 4.8).

Razdan *et al.*, (1969) also reported lower values of RBC in Tharparkar males of almost similar age group, housed in shelter compared to control. Whereas Friend *et al.*, (1985) reported some what higher RBC counts in calves confined under different management conditions.

RBC count had significant difference between groups and periods $p<0.01$, (Table 4.10). RBC count had negative correlation with THI and physiological parameters in both the groups (Table 4.11 and 4.12)

But Razdan *et al.*, (1969) did not find any significant relation between RBC count and ambient temperature.

4.2.4 Total Leucocyte count

During the entire period of study the mean value of TLC was 9523 ± 126/cu mm for group I and 9947 ± 145/cu mm for group II. The values come in the range of 8500 to 12500/cu mm reported by Greatorex (1952).

The mean value of TLC for group I during first period was 9634 ± 229/cu mm and for group II it was 9601 ± 267/cu mm. The mean TLC value for second period for group I was 9412 ± 107/cu mm and in group II it was 10294±82/cu mm, showing a clear tendency of increasing TLC in control group (Table 4.9).

Friend *et al.*, (1985) and Reece and Hotchkiss (1987) reported a TLC in the range of 6900 to 9700/cu mm and 6917 to 11336/cu mm in calves respectively.

There was significant difference $p<0.01$, (Table 4.10) between two groups, but no significant difference between the periods. The correlation between TLC and THI was negative (-0.01) in experimental group and positive in control group (0.13).

Dantzer *et al.*, (1983) suggested that TLC can be used as physiological measurements of stress. Radadia *et al.*, (1969) didn't find any correlation between TLC and ambient temperature.

4.2.5 Differential Leucocyte Count

Mean values of percentage of Lymphocytes, Neutrophils, Eosinophils and Monocytes for group I were 71.4 ± 0.61, 25.75 ± 0.65, 2.18 ± 0.11 and 1.5 ± 0.12 respectively. The respective values for group II were 69.4 ± 0.7, 27.85 ± 0.7, 2.23 ± 0.1 and 1.59 ± 0.1 respectively (Table 4.9).

These values are in agreement with those reported by Reece and Hotchkiss (1989) and Friend *et al.*, (1985). There was significant difference ($p<0.01$) between groups for Lymphocyte percentage. The difference was significant ($p<0.01$) between two periods for lymphocytes and neutrophils. Eosinophils and Monocyte did not show any significant difference between groups or between periods.

The correlation among different parameters were similar in two groups (Table 4.11 and 4.12)

The neutrophil to lymphocyte ratio for experimental group was 0.37 ± 0.01 and for control group 0.41 ± 0.03 (Table 4.9). N:L ratio was used to measure stress in veal calves by Friend *et al.*, (1985), Gross and Siegel (1983) reported that high ratio is an indicator of stress and may be more reliable than cortisol level.

Reece and Hotchkiss (1989) reported a percentage of lymphocyte ranging from 64.3 to 71.7% and neutrophil percentage in the range of 27.1 to 34.3. In the present study also, the values are in general agreement with Reece and Hotchkiss (1989).

Table 4.8: Mean ± S.E. of different Haematological parameters under two housing conditions in crossbred males.

Groups	Periods	No. of observation	PCV (%)	Hb (g. %)	RBC millions/mm^3	MCV (μm^3)	MCH (p g)	MCHC (%)
Experimental Group	Period I	35	35.28 ± 0.45	13.31 ± 0.20	6.39 ± 0.14	55.95 ± 1.06	20.98 ± 0.43	37.77 ± 0.47
	Period II	35	32.97 ± 0.34	12.0 ± 0.15	6.06 ± 0.09	55.34 ± 0.94	19.06 ± 0.35	36.21 ± 0.29
	Overall	70	34.13 ± 0.32	12.65 ± 0.15	6.22 ± 0.09	55.61 ± 1.12	20.51 ± 0.71	36.98 ± 0.52
Control Group	Period I	35	35.82 ± 0.37	13.85 ± 0.16	6.97 ± 0.13	51.87 ± 0.86	20.35 ± 0.39	38.77 ± 0.45
	Period II	35	33.31 ± 0.35	12.07 ± 0.15	6.57 ± 0.10	50.81 ± 0.46	18.44 ± 0.20	36.23 ± 0.32
	Overall	70	34.57 ± 0.29	12.95 ± 0.15	6.77 ± 0.09	51.41 ± 1.22	19.34 ± 0.48	37.53 ± 0.40

Table 4.9: Mean ± S. E. for Haematological and hormonal parameters under two housing conditions in crossbred males.

Groups	Periods	No. of obs.	TLC (/mm^3)	Lymphocytes (%)	Neutrophils (%)	Eosinophils (%)	Monocytes (%)	N : L Ratio	Cortisol (ng/ml)
Group I	Period I	35	9634.29 ± 229.4	69.0 ± 0.97	28.6 ± 1.0	2.03 ± 0.14	1.53 ± 0.16	0.42 ± 0.02	8.19 ± 0.60
	Period II	35	9412.86 ± 106.6	73.7 ± 0.52	23.51 ± 0.67	2.31 ± 0.17	1.44 ± 0.16	0.32 ± 0.01	3.8 ± 0.45
	Overall	70	9523.0 ± 126.3	71.4 ± 0.61	25.75 ± 0.65	2.18 ± 0.11	1.5 ± 0.12	0.37 ± 0.01	6.03 ± 0.45
Group II	Period I	35	9601.0 ± 267.5	68.1 ± 1.06	29.17 ± 1.12	2.06 ± 0.2	1.5 ± 0.16	0.44 ± 0.02	8.69 ± 0.80
	Period II	35	10294 ± 82.32	70.6 ± 0.92	25.94 ± 0.83	2.38 ± 0.20	1.65 ± 0.14	0.37 ± 0.02	3.80 ± 0.43
	Overall	70	9947 ± 145.03	69.4 ± 0.71	27.85 ± 0.72	2.23 ± 0.13	1.59 ± 0.10	0.41 ± 0.03	6.24 ± 0.54

Fig. 4.6: Mean ± S. E. values of Packed cell volume (%) for experimental and control group.

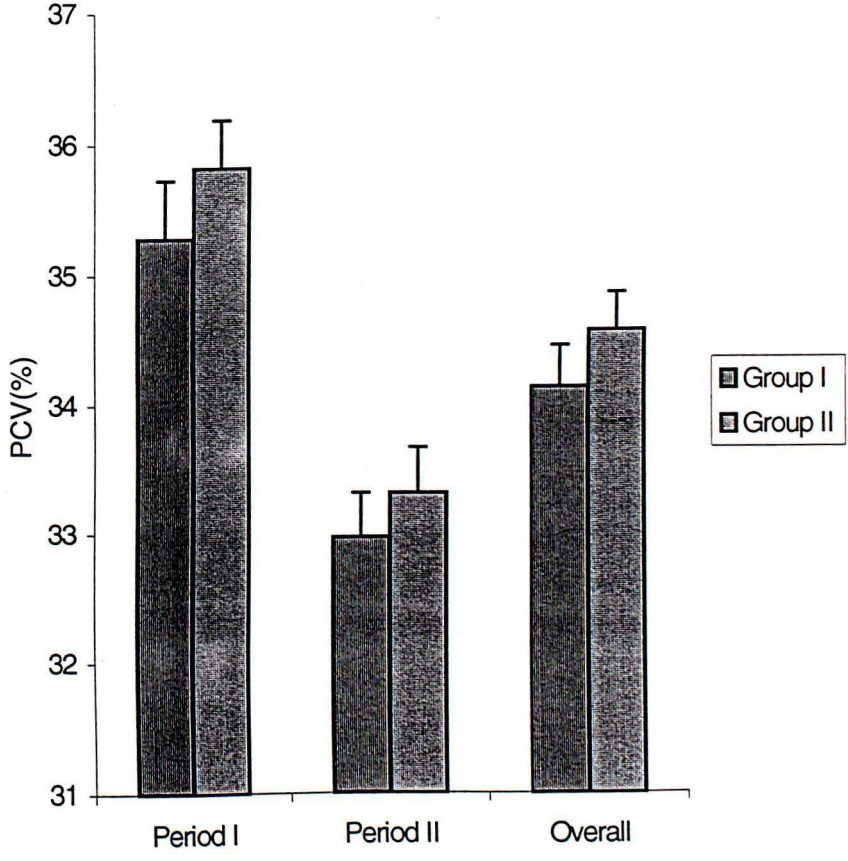
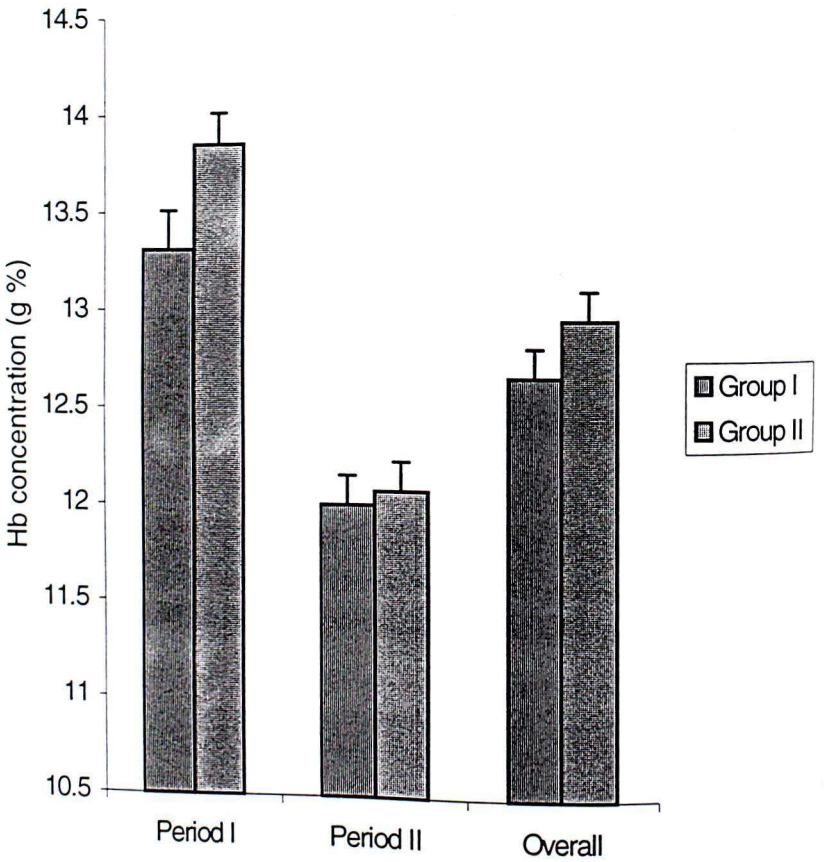


Fig. 4.7: **Mean ± S. E. values of Haemoglobin concentraion (gm %) for experimental and control group.**



can't difference between G.I & G.II

Fig. 4.8: **Mean ± S. E. values of red blood cell concentration (millions/cu mm) for experimental and control group.**

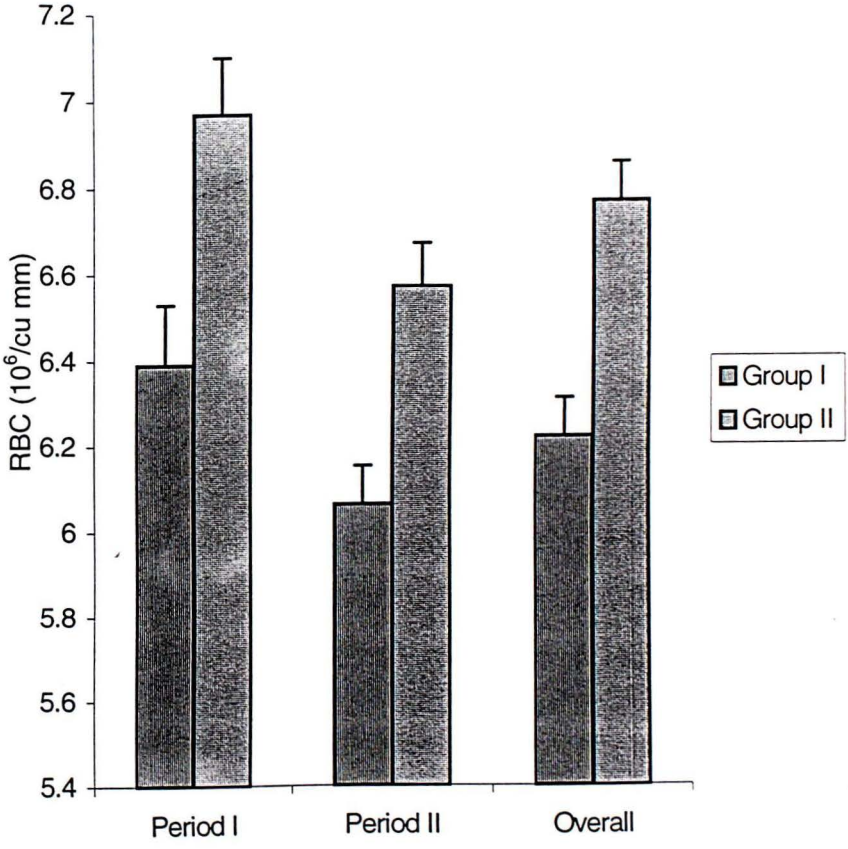


Fig. 4.9: **Mean ± S. E. values of total leucocyte count (10^3/cu mm) for experimental and control group.**

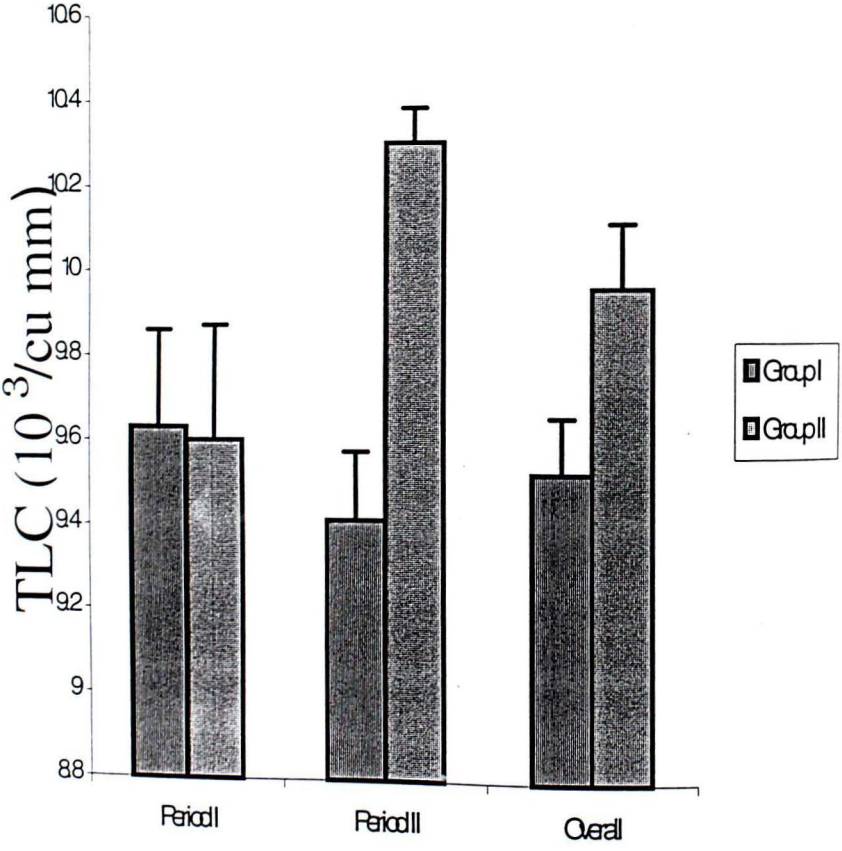


Fig. 4.10: **Mean ± S. E. values of plasma cortisol level (ng/ml) for experimental and control group.**

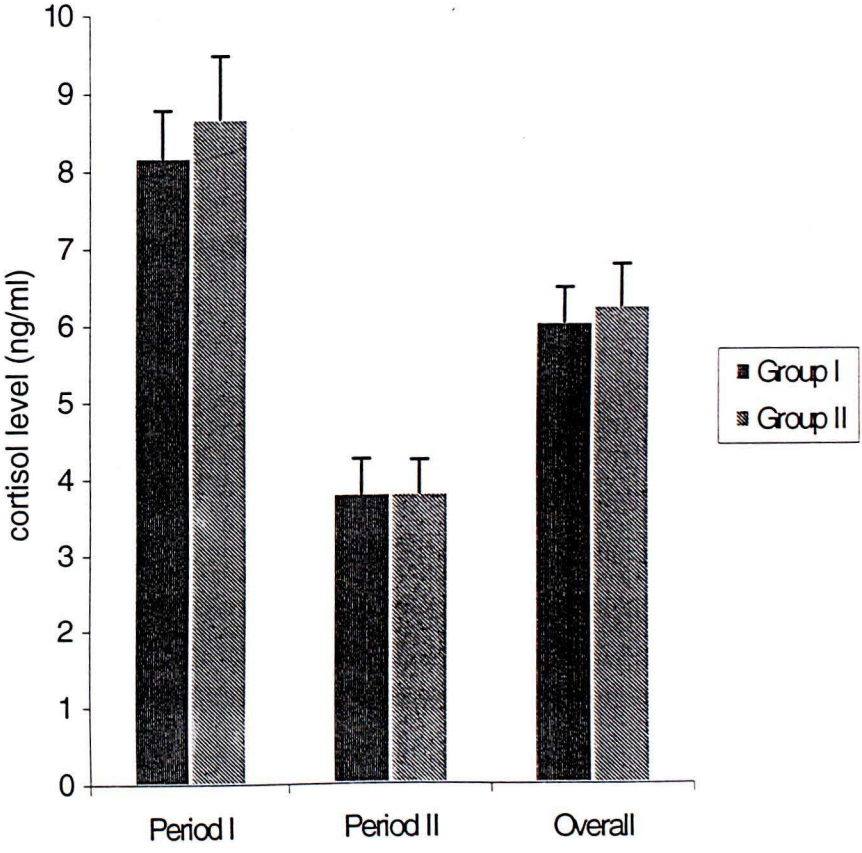


Table 4.10: Analysis of variance of different Haematological and hormonal parameters of crossbred males.

Source of Variation	d.f	M. S. S								
		PCV	Hb	RBC	TLC	Lymphocytes	Neutrophils	Eosinophils	Monocytes	Cortisol
Between groups	1	6.864	3.180	10.53**	6300642*	140*	113.4	0.082	0.150	1585785
Between Season	1	204.07**	83.16**	4.60**	1944643	453.6**	520.71**	2.937	0.018	0.742×10^9**
Season × Groups	1	0.349	1.89	0.0429	7314285*	43.5	13.82	0.105	0.300	2811611
Error	136	5.16	0.984	0.505	1245087	27.8	29.74	0.92	0.52	12115136

** Significant at 1% level. * Significant at 5% level.

Table 4.11: Correlation coefficients between different physiological, haematological, hormonal parameters and THI in Group I.

	PCV	Hb.	RBC	WBC	L	N	E	M	Cortisol	R. R.	H. R.	R. T.	S. T.	T. H. I.
PCV	1.00													
Hb.	0.74**	1.00												
RBC	0.56**	0.46**	1.00											
WBC	-0.17	-0.09	-0.12	1.00										
L	-0.20	-0.26*	-0.28*	0.07	1.00									
N	0.18	0.25*	0.27*	-0.05	-0.95**	1.00								
E	-0.12	-0.21	-0.17	-0.17	0.06	-0.22	1.00							
M	0.14	0.10	0.12	-0.01	-0.001	-0.17	-0.03	1.00						
Cortisol	0.20	0.28*	0.22	0.04	-0.33**	0.30**	-0.22	0.16	1.00					
R. R.	-0.29*	-0.31**	-0.07	-0.17	-0.35**	-0.34**	0.20	-0.10	-0.29*	1.00				
H. R.	-0.29*	-0.03	0.04	0.01	0.32**	-0.34**	0.04	0.06	-0.28*	0.27*	1.00			
R. T.	-0.24*	-0.22	-0.11	-0.11	0.19	-0.20	-0.02	0.09	0.02	0.40**	0.27*	1.00		
S. T.	-0.32**	-0.34**	-0.11	-0.09	0.50**	-0.4**	0.11	-0.07	-0.54**	0.51**	0.44**	0.324**	1.00	
T. H. I.	-0.30*	-0.34**	-0.15	-0.01	0.53**	-0.5**	0.1210	-0.19	-0.58**	0.37**	0.483**	0.16	0.78**	1.00

** Significant $p < 0.01$ * Significant $p < 0.05$

Table 4.12: Correlation coefficients between different physiological, haematological, hormonal parameters and THI in Group II.

	PCV	Hb.	RBC	WBC	L	N	E	M	Cortisol	R. R.	H. R.	R. T.	S. T.	T. H. I.
PCV	1.00													
Hb.	0.72**	1.00												
RBC	0.65**	0.44**	1.00											
WBC	-0.40**	-0.38**	-0.42**	1.00										
L	-0.13	-0.12	0.16	0.02	1.00									
N	0.17	0.29*	-0.14	-0.02	-0.95**	1.00								
E	-0.09	-0.25*	-0.18	0.13	-0.22	-0.04	1.00							
M	-0.25*	-0.35**	-0.18	0.05	-0.14	-0.12	0.48**	1.00						
Cortisol	0.25*	0.54**	0.16	-0.18	-0.22	0.30*	-0.26*	-0.29	1.00					
R. R.	-0.05	-0.25*	-0.44	0.09	0.24	-0.27*	0.17	0.06	-0.34**	1.00				
H. R.	-0.18	-0.15	0.10	-0.10	0.13	-0.11	-0.67**	-0.04	0.05	0.10	1.00			
R. T.	-0.31**	-0.5**	-0.38**	0.32**	0.17	-0.17	0.14	0.08	-0.38**	0.36**	0.14	1.00		
S. T.	-0.51**	-0.66**	-0.30*	0.19	0.21	-0.27*	0.23	0.22	-0.50**	0.29*	0.31**	0.53**	1.00	
T. H. I.	-0.43**	-0.74**	-0.19	0.13	0.30*	-0.36**	0.17	0.23	-0.62**	0.25*	0.34**	0.51**	0.81**	1.00

** Significant $p < 0.01$ * Significant $p < 0.05$

4.2.6 MCHC, MCV and MCH

The mean values for MCV, MCH and MCHC 55.61 ± 1.12 μm^3, 20.51 ± 0.71 pg, 36.98 ± 0.52% respectively for group I. The respective values for group II were 51.41 ± 1.22 μm^3, 19.34 ± 0.48 pg, and 37.53 ± 0.40%. Lower values were observed for control group. Reece and Hotchkiss (1987) reported MCV, MCH and MCHC values 39.4, 12.8 and 32.6 respectively in calves. These values in this experiment did not show any significant difference among two housing systems.

4.3 Cortisol

Level of cortisol in plasma has been used as stress indicator. In this experiment the plasma level of cortisol, varied from 0.84 ng to 19 ng/ml. The levels were high in the initial period of experiment when the ambient temperature was generally low (Table 4.9).

A slightly higher values were observed in group II. The mean value for experimental group was 6.03 ng/ml and in control group it was 6.24 ng/ml.

The higher negative correlation was found between THI and cortisol in the first period in both experimental and control group (-0.5050 and -0.5800) correlation was low in the second period of the experiment (0.0853 and -0.0027), in experimental and control group respectively (Table 4.11 & 4.12).

There was decrease in plasma cortisol level with increase in ambient temperature. The similar trend was reported by Yousef and Johnson (1967) and Stott and Wiersma (1971), Ingram *et al.*, (1979) in different categories of animals.

Gettys *et al* (1988) reported the mean value, in bull as 22, 22, 24, 26, 17, 19, and 14 ng/ml during 10, 11, 12, 13, 14, 15 and 16 months of age respectively.

4.4 Feed Intake and Growth

The Mean DMI for the group I was 5.57 ± 0.66 kg and for the group II it was 5.2 ± 0.177 kg. The mean values of DMI, Body weight, Body length, Heart girth, and height at whithers, for both the groups have been presented in the (Table 4.13).

Singh, (1982), reported a higher DMI gain in sheltered young buffaloes in hot dry season. In this experiment the average daily gain for group I and groups II were 631.8 ± 93.31 and 636.2 ± 114.6 gm. Karki *et al.*, (1983) also found non significant difference in the weight gain in buffalo heifers housed under three different types of shelter similar non significant difference in body weight and feed intake was also observed by Patel *et al.*, (1995), Whereas Singh *et al.*, (1985) reported higher body weight gain in buffalo calves kept in open during night than those kept in sheds. ANOVA (Table 4.14) indicates significant difference between body weight during the different months and groups.

The mean body length for February, March, April and May for group I were, 94.6 ± 0.67, 96.8 ± 0.8, 98.0 ± 0.89, and 10.14 ± 0.97 cms, respectively, showing linear relationship between the age and body length. The respective values for control group were 92.28 ± 3.49, 94.8 ± 3.49, 95.4 ± 3.38, 92.4 ± 3.38 cms, also showing similar whereas relationship as in case of group I (Table 4.13).

The mean values of heart girth of the group I for February, March, April, and May were, 129.4 ± 3.02, 133.4 ± 3.02, 140.4 ± 2.65, 145.8 ± 2.01 cms, respectively. The respective values for control group were 123.0 ± 3.08, 127.6 ± 3.10, 129.8 ± 3.02, and 135.8 ± 2.43 cms. Both the groups showed linear relationship between heart girth and age and group I had shown consistently higher increase in the body measurement.

The mean values of height of group I for February, March, April, and May were 105.2 ± 1.07, 107.2 ± 1.07, 108.0 ± 0.95, and 113.2 ± 0.73 cms, respectively and for group II the respective values were, 104.6 ± 2.11, 106.6 ± 2.11, 107.4 ± 2.16 and 107.8 ± 2.18 cms respectively (Table 4.13).

Sastry *et al.*, (1981) reported 16% higher weekly gain in buffaloes sprinkled with cold water and the had covered with double layers of hessian cloth when compared to control.

Patel *et al.*, (1995) reported that RH had the highest effect on body weight and feed efficiency. Minimum temperature was more responsible for changes in weight gain.

Table 4.13: Mean ± S.E. of Monthly DMI, Body weight and Body dimensions.

Animal Groups	Months	No. of Observations	DMI (Kg)	Body Weight (Kg)	Body length (cm)	Heart girth (cm)	Height (cm)
Group I	February	5	5.57±0.66	150±8.36	94.6±0.67	129.4±3.02	105.2±1.07
	March	5	5.90±0.15	170±6.68	96.8±0.8	133.4±3.72	107.2±1.07
	April	5	5.73±0.04	194±7.48	98.0±0.89	140.4±2.65	108.0±0.95
	May	5	5.51±0.17	210±9.51	101.4±0.97	145.8±2.01	113.2±0.73
	Overall	20	5.68±0.16	181±6.44	97.7±40.68	137.3±1.91	108.4±0.8
Group II	February	5	4.95±0.38	130±4.68	92.8±3.49	123.0±3.08	104.6±2.11
	March	5	4.91±0.57	151±7.2	94.8±3.49	127.6±3.1	106.6±2.11
	April	5	5.52±0.01	173±10.29	95.4±3.38	129.8±3.00	107.4±2.16
	May	5	5.50±0.76	196±14.23	97.4±2.92	135.8±2.43	107.8±2.18
	Overall	20	5.22±0.177	163±7.20	95.1±1.57	129.1±1.71	106.6±1.02

Table 4.14: Analysis of variance for DMI, Body weight, Body Measurements and THI of crossbred males under two housing conditions.

Source of variation	d.f	M. S. S.					
		DMI	Body weight	Body length	Heart girth	Height	THI
Between groups	1	2.1068	3348.9**	67.60	672.39**	32.40	3.6
Between months	3	0.239	7526.16**	55.80	392.16**	53.86*	484.41**
Groups × months	3	0.469	18.16**	2.467	15**	14.40	3.49
Error	32	0.63	402.25	29.59	39.97	13.77	3.52

**** Significant p < 0.01** *** Significant p < 0.05**

Table 4.15: Correlation coefficients of mean monthly Body weight, DMI, Length, Heart Girth, Height and THI for Group I.

	DMI	Body weight	Length	Girth	Height	THI
DMI	1.0000					
Body weight	0.0161	1.0000				
Body length	0.0184	0.7025**	1.0000			
Heart girth	0.2355	0.7586**	0.8804**	1.0000		
Height	0.2314	0.7881**	0.5053**	0.4360**	1.0000	
THI	-0.0638	0.7074**	0.7939**	0.6632**	0.8244**	1.0000

** Significant $p < 0.01$

Table 4.16: Correlation coefficients of mean monthly Body weight, DMI, Length, Heart Girth, Height and THI for Group II.

	DMI	Body weight	Length	Girth	Height	THI
DMI	1.0000					
Body weight	0.4265*	1.0000				
Body length	0.5129*	0.6766**	1.0000			
Heart girth	0.4818*	0.8495**	0.8295**	1.0000		
Height	0.4154	0.6317**	0.8282**	0.8290**	1.0000	
THI	0.2564	0.6708**	0.2138	0.5716**	0.1750	1.0000

** Significant $p < 0.01$ * Significant $p < 0.05$

Table 4.17: Body weight gain in different animals of group I.

Animal No.	Date of Birth	Initial Body weight	Final Body Weight (Kg)	Weight gain (kg)	ADG (g)
1	09.01.2000	125	238	113	856
2	10.02.2000	110	218	108	818
3	04.03.2000	100	182	82	621
4	21.04.2000	150	216	66	500
5	04.07.2000	150	198	48	364
Mean		127.0±10.2	210.4±9.5	83.4±12.3	631±93.3

Table 4.18: Body weight gain in different animals of group II.

Animal No.	Date of Birth	Initial Body weight	Final Body Weight (Kg)	Weight gain (kg)	ADG (g)
6	14.01.2000	120	183	63	477
7	25.02.2000	165	202	97	735
8	05.03.2000	110	246	136	1030
9	27.04.2000	115	189	74	561
10	31.07.2000	110	160	50	378
Mean		124.0±10.4	196±14.2	84±15.12	636.2±114.57

CHAPTER - 5

SUMMARY AND CONCLUSIONS

5 Summary and conclusion

To compare the effect of two housing conditions on physiological, haematological, hormonal, feed intake and growth parameters. Apparently healthy 10 crossbred males were selected from NDRI herd and divided into two groups (5 each) and group I was maintained under modified housing conditions and group II under normal existing conditions. The feeding schedule for both of the groups were same as followed at NDRI farm. The experiment was conducting from February to May (14 weeks). The observations recorded during the study were divided into two periods i.e. Period I (first seven observations) and the second period consisting of remaining seven observations.

The environmental variables viz., Minimum and Maximum temperature, Dry and wet bulb temperature, relative humidity, Globe thermometer temperature etc. were recorded during the entire period of the study.

The physiological reactions viz., respiration in rate, Pulse rate, rectal temperature and skin temperature increased as the environmental temperature increase in both the groups. These physiological reactions were found to be higher in group II as compared to Group I. The observations recorded during morning and evening was found to be significantly different in both the groups.

The positive ($P < 0.01$) correlation coefficient was found between THI and the physiological reactions in both the groups. Negative correlation coefficient was found between physiological reactions and Hb and PCV. The level of cortisol was also found to negatively correlated with different physiological reactions.

The increase in RR and HR in group II and in period II in both groups ensured the supply of sufficient oxygen to tissue for maintaining homeothermy. The haematological parameters viz., packed cell volume, haemoglobin and red blond corpuscles showed higher values in group II as compared to group I. Further the values of these parameters were found to be higher in period I in both of the group as compared to period II, indicates the negative correlation with THI. The MCV, MCH and MCHC also showed a similar pattern of lower values in group II and higher values in Period I as compared to

group I and period II respectively. This may be due to changes in extra cellular fluid volume during increased THI.

The WBC concentration was found to be higher in group II as compared to I, but during the period I and Period II no specific pattern was found. The differential leucocyte counts showed the similar pattern of increase/decrease in both the groups and Periods. Neutrophils and lymphocytes ratio was calculated to find the stress levels on the animals. The values were found to be much lower than the level of stressed value reported by earlier authors.

The ANOVA of data indicated a significant variation in PCV, Hb, RBC and lymphocytes between the two periods. The PCV, Hb and RBC were found to be positively correlated with cortisol and negatively with THI in both of the groups.

The average dry matter intake of group I was found to be slightly higher than group II but the values were not significantly different. The average weight gain during the study period was 84±15.12 kg in group II and 83.4 kg in group I indicates the average daily weight gain almost similar in both of the groups. The analysis of variance showed a significant variation in body weight and in different body measurement during different months of the study.

The correlation coefficient indicates the positive correlation between DMI and other parameter i.e. body weight, body length, Heart girth, and height.

On viewing the results from all perspective, it is clear that THI had the effect on the animal system. The exposure of animals to direct solar radiation had an addition effect and therefore proper shelter is important for checking the extreme variations.

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