Effect of Working on Physiological, Biochemical and Haematological Parameters in Hariana Bullocks

A. S. Yadav, S. S. Dhaka and B. Kumar
Department of Animal Breeding, CCS Haryana Agricultural University Hisar-125 004, India

ABSTRACT: An experiment was conducted on eight bullocks of Hariana cattle study draft efficiency using different appliances, changes in their physiological, biochemical and haematological parameters, and how the body tries to maintain these within normal physiological range. Blood collection was done at pre-exercise, three hours after exercise and two hours post exercise in summer and winter seasons of the year 1990-91. Average pulse rate and respiration rate per minute were found to be 63.09±0.78, 25.60±0.54, 97.21±2.51, 63.37±2.70, 64.05±1.90, 25.33±1.20, respectively, at pre-exercise, three hours exercise and two hours post exercise rest. The seasonal differences were found to significant and the values were higher in summer than in winter. After two hours post exercise rest Hariana bullocks regained their normal values for all the parameters, except that pulse rate, respiration rate and serum sodium during summer did not reach the pre-exercise levels. (Asian-Aust. J. Anim. Sci. 2001. Vol 14, No. 8 : 1067-1072)

Key Words: Draught, Physiological, Biochemical, Haematological, Hariana Breed

INTRODUCTION

The work capacities of bullocks which supply more than half of the power requirement of farmers in South East Asian countries have not been evaluated properly (Ramaswamy, 1981). Limited studies have been conducted on the effect of submaximal work on blood metabolites, biochemical and physiological responses of bullocks to work (Georgie et al. 1970; Acharya et al. 1979; Rao and Upadhaya, 1984; Upadhaya and Madan, 1987; Yadav et al. 1997). Hariana breed of cattle is the famous dual-purpose breed of Northern India; hence the present study was planned to determine the effect of working on their biochemical, physiological and haematological parameters.

MATERIALS AND METHODS

The investigation was made with 8 bullocks of Hariana breed belonging to the project "Genetic improvement of indigenous breeds of cattle (Hariana Unit)" being monitored and coordinated by Project Directorate on cattle, Meerut since 1987. The animals are maintained in the Department of Animal Breeding, Haryana Agricultural University, Hisar. The bullocks were trained prior to the start of the experiment and other routine management practices were similar for all the bullocks through out the experimental period.

Experimental period

The experiment was conducted in two seasons: winter (Feb. - March) and summer (June - July). Four different draft levels were imposed in these seasons.

Pairing of bullocks

On the basis of similarity in their body weight, bullocks were grouped into different working groups.

Experimental schedule

Two trials, one for ploughing and the other for carting were conducted. In the ploughing trial, pairs of the bullocks were put to ploughing continuously for a period of three hours a day in each season. In the carting trial, pulling three different loads viz., 14 quintals, 14 quintals plus 25 per cent of body weight of the pairs and 14 quintals plus 40 per cent of the body weight of the pairs were tested continuously for a period of three hours. In this way there were four different levels for each pair of bullocks and each draft level was repeated three times in each season after giving two days rest between two draft levels so that carry over effect of previous trial was eliminated.

Physiological parameters

The physiological observations were recorded using standard techniques. The pulse rate was recorded by palpating the coccygeal artery for one minute. Respiration rate noted by counting the gushes of expired air at the back of the hand kept near the nostrils of the bullocks for one minute. The body temperature was recorded using a clinical thermometer inserted into the rectum for a minute. Care was taken to keep the bulb of thermometer in close contact with the rectal mucosa.

Blood collection and analysis

Blood was collected from the jugular vein in two lots: (i) with EDTA as an anticoagulant, and (ii) with no anticoagulant for separation of blood serum. The blood collection and recording of physiological observations were made 10-15 minutes prior to the start of the experiment, after giving three hours of exercise to the animals, and post
exercise after two hours rest. Hemoglobin content was estimated by Cyanmeth hemoglobin method using Drobkin’s solution. R.B.C. and W.B.C. counts were done by Neubauer’s counting chamber (Wintrobe,1962). Lactic acid was estimated according to the method described by Barker and Summers (1941). Sodium and potassium in serum were estimated by Oser (1965), using a flame photometer. All the methods of analysis were standardized prior to the start of experiment.

**Statistical methods**

The data generated from this study were analyzed by assuming the following fixed effects mathematical model:

\[ Y_{ijk} = \mu + S_i + I_j + (SI)_{ij} + e_{ijk} \]

where,

- \( Y_{ijk} \) is the \( k \)th observation in \( j \)th interval in \( i \)th season
- \( \mu \) = overall mean
- \( S_i \) = season effect
- \( I_j \) = interval effect
- \( (SI)_{ij} \) = interaction of season and interval
- \( e_{ijk} \) = random error assumed to be NID (0, \( \sigma^2 \)).

The multiple interactions were assumed as non-significant. The data were analyzed to test the significance of main effects and interactions as per standard techniques. The preliminary analysis of data revealed that interactions effect were non-significant and the data were pooled for analysis of main effects as per Snedecor and Cochran (1968).

**RESULTS AND DISCUSSION**

**Physiological parameters**

Analysis of data for mean and their standard errors of physiological parameters (pulse rate, respiration rate and rectal temperature) is presented in table 1. Effects of different draft levels were non-significant, hence the data were pooled for draft levels.

*Pulse rate:* A means pulse rate showed a significant effect of seasons (p<0.05) at all the three intervals. The overall mean before commencement of exercise for pulse rate was 63.09±0.78 per minute. During exercise, the pulse rate rose to 97.21±2.51. At the end of the two hours rest the values showed similar trend to the pre-exercise level. The greater increase in pulse rate may be due to increased metabolic rate to provide more energy to muscles and to dissipate the extra heat load. Percent increase in pulse rate at a particular work load is an indicator of functioning capacity of cardiovascular system. Thus, the pulse rate can be considered as a criterion for judging the working capacity of bullocks.

During the summer season, pulse rate was higher as compared to winter season at pre-exercise level, after three hours of continuous exercise, and at two hours rest after exercise. In winter the average pulse rate at pre-exercise level was 59.12±1.40 which was restored at the end of the two hours rest after exercise, whereas in summer basal values were not restored in that period. The present findings are contrary to those reported by Gattewar (1983). However, the conclusions drawn by Bhutani and Nangia (1976); Acharya et al. (1979); Garg et al. (1981); Upadhyaya and Madan (1982); Satija (1983); Sree Kumar and Thomas (1990) are in agreement with the present findings.

*Respiration Rate:* Significant differences in respiration rate due to different intervals and seasons were observed and the overall mean respiration rate was 25.60 ± 0.54 per minute. It rose to 63.37 ± 2.70 after three hours of exercise. The increase in percent respiration rate was 148 before exercise and after three hours of exercise. Two hours rest was sufficient to recover the basal values.

In summer, respiration rate was higher at pre-exercise level as well as during three hours of exercise than in winter. In winter, respiration rate increased by 150 percent whereas the increase was 132 percent after three hours exercise. In summer, the values of respiration rate at pre - exercise level could not be attained after two hours post exercise rest whereas reverse results were obtained in the winter. The studies by Maurya (1982), Rautary and Srivastava (1982), Rao and Upadhyaya (1984) are in agreement with the present findings.

*Rectal Temperature:* The Hariana bullocks had a rectal temperature of 100.80±0.05 (°F) at pre-exercise. The rectal temperature rose significantly up to 103.31±0.16 (°F) at the end of the three hours exercise. At the end of two hours rest the values were near to the pre-exercise level. The change in body temperature might be attributed to heat production as a result of muscle contraction during work. Increase in rectal temperature as a response to exercise was also reported by Sastry et al. (1970), Rana et al. (1978), Satija et al. (1983), Upadhyaya and Madan (1985) and Sree Kumar and Thomas (1990).

Table 1 shows that rectal temperature was higher at zero hour in summer (101.23±0.03°F) than in winter (100.82±0.05°F). Body temperature in both seasons rose with exercise, and at the end of the three hours of exercise it reached 104.43 ± 0.23 and 103.02±0.12°F in summer and winter, respectively. Similar increases in rectal temperature of bullocks in summer vs. winter have been reported by Agarwal et al. (1982), Acharya et al. (1979) and Maurya and Devadatt (1986). No attainment of body temperature at pre-exercise level in summer after two hours of rest indicated that during summer months there is more stress on the bullocks than during winter months.

**Biochemical parameters**

Homeostatic mechanisms are more or less reflected in
Table 1. Means and their standard errors of different physiological parameters in Hariana bullocks

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Season 1</th>
<th>Season 2</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse rate/min</td>
<td>Before exercise (0)</td>
<td>59.12±1.40</td>
<td>66.22±1.74</td>
</tr>
<tr>
<td></td>
<td>After two hours of (1) exercise</td>
<td>86.92±3.40</td>
<td>107.33±4.40</td>
</tr>
<tr>
<td></td>
<td>Two hours post exercise</td>
<td>60.54±1.41</td>
<td>68.56±1.63</td>
</tr>
<tr>
<td>Respiration rate/min</td>
<td>Before exercise (0)</td>
<td>22.46±0.09</td>
<td>28.87±1.35</td>
</tr>
<tr>
<td></td>
<td>After two hours of (1) exercise</td>
<td>53.29±4.22</td>
<td>73.45±5.99</td>
</tr>
<tr>
<td></td>
<td>Two hours post (2) exercise</td>
<td>23.87±0.98</td>
<td>26.81±3.51</td>
</tr>
<tr>
<td>Rectal temperature (°F)</td>
<td>Before exercise (0)</td>
<td>100.82±0.05</td>
<td>101.23±0.03</td>
</tr>
<tr>
<td></td>
<td>After two hours of (1) exercise</td>
<td>103.03±0.12</td>
<td>104.43±0.23</td>
</tr>
<tr>
<td></td>
<td>Two hours post (2) exercise</td>
<td>101.19±0.03</td>
<td>101.78±0.15</td>
</tr>
</tbody>
</table>

Means superscripted by different letters and numbers differ significantly (p<0.05) among themselves. Alphabetical superscripts are for row comparison. Numerical superscripts are for column comparison.

Changes in certain blood biochemical parameters. Homeothermic animals achieve heat dissipation by respiratory cooling, salivation and peripheral vascular dilation, with a variable contribution from sensible and insensible cutaneous heat loss. Therefore, some of important biochemical parameters (lactic acid, serum sodium and serum potassium) were considered for investigation and are presented in table 2.

Lactic Acid: Analysis of means for lactic acid showed a significant effect of seasons at all the three intervals. The overall mean for lactic acid content in blood serum before start of exercise was 11.93±0.20. During the exercise, the lactic acid content rose to 37.03±0.86. At the end of two hour rest the values were almost similar to the pre-exercise levels.

In summer, there was significantly higher lactic acid than in winter at pre-exercise level, and this trend continued during exercise and at rest. The higher lactic acid content in summer may be because of a higher metabolic rate to maintain the body temperature. After three hours of exercise, lactic acid increased by 217 and 203 percent in summer and winter season, respectively. After two hours rest, post-exercise lactic acid content returned near to pre-exercise levels in both seasons. Increase in lactic acid content is natural as the demand of oxygen increased for ATP formation by oxidation of carbohydrates. Usually, the maximum possible increase in O₂ consumption during exercise is not more than 200 to 300 percent whereas the rate of ATP utilization is almost 1000 times the basal rates. Therefore, it is apparent that the process of anaerobic mechanism for rapid generation of ATP is activated. Percent increase in blood lactic acid was more with higher draft level, and it was in agreement with the study of Gattewar (1983) in buffaloes.

Serum sodium: Analysis of means for serum sodium revealed that seasons and continuous exercise for three hours were significant. The sodium content in the serum was 141.35±0.18 M. Eq/Litre before exercise and its level reached 145.45±0.09 M. Eq/Litre after three hours of continuous exercise. The difference between the basal value and the level obtained in the blood two hours post exercise was minimum and not significant. The higher level of serum sodium after the continuous three hours exercise may be due to release of aldosterone from the adrenal cortex during exercise which prevents the sodium elimination in the blood.

Pre-exercise values for serum sodium in summer and winter were 140.55±0.21 and 142.12±0.27, respectively, whereas corresponding figures after two hours post-exercise rest were 141.24±0.16 and 142.55±0.24, showing that two hours rest was not sufficient to restore the pre-exercise values of serum sodium during summer. This is not in agreement with Gattewar (1983) where two hours rest was sufficient to restore the original values.

Serum potassium: The potassium content in the serum was observed significantly lower (table 2) at exercise than at rest. The value decreased from 6.42±0.07 to 5.26±0.17 M. Eq/Litre, and pre-exercise levels were not attained in two hours of post exercise rest. The significantly lower value for potassium in the blood during exercise might be due to respiratory alkalosis resulting from lowering bicarbonate level and thereby elevating pH of blood, besides functioning in haemoglobin buffer mechanism which prevents the rise in plasma pH by decreasing carbonate. The cellular exchange process also participates in such disturbances. In respiratory alkalosis Na⁺ exchanges for
Table 2. Means and their standard errors of different biochemical parameters in Hariana bullocks

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Season 1</th>
<th>Season 2</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactic acid</td>
<td>Before exercise (0)</td>
<td>11.19&lt;sup&gt;i&lt;/sup&gt;±0.23</td>
<td>12.65&lt;sup&gt;ib&lt;/sup&gt;±0.21</td>
</tr>
<tr>
<td>(mg %)</td>
<td>After two hour of (1)</td>
<td>33.91&lt;sup&gt;ia&lt;/sup&gt;±0.99</td>
<td>40.14&lt;sup&gt;ib&lt;/sup&gt;±0.89</td>
</tr>
<tr>
<td></td>
<td>Two hours post (2)</td>
<td>11.99&lt;sup&gt;i&lt;/sup&gt;±0.23</td>
<td>13.25&lt;sup&gt;ib&lt;/sup&gt;±0.21</td>
</tr>
<tr>
<td>Serum</td>
<td>Before exercise (0)</td>
<td>142.12&lt;sup&gt;ib&lt;/sup&gt;±0.27</td>
<td>140.55&lt;sup&gt;ib&lt;/sup&gt;±0.21</td>
</tr>
<tr>
<td>Sodium (M Eq/Litre)</td>
<td>After two hour of (1)</td>
<td>144.90&lt;sup&gt;ab&lt;/sup&gt;±0.17</td>
<td>145.86&lt;sup&gt;ab&lt;/sup&gt;±0.17</td>
</tr>
<tr>
<td></td>
<td>Two hours of (2)</td>
<td>142.55&lt;sup&gt;ib&lt;/sup&gt;±0.24</td>
<td>141.24&lt;sup&gt;ib&lt;/sup&gt;±0.16</td>
</tr>
<tr>
<td>Serum</td>
<td>Before exercise (0)</td>
<td>6.17&lt;sup&gt;a&lt;/sup&gt;±0.12</td>
<td>6.66&lt;sup&gt;b&lt;/sup&gt;±0.02</td>
</tr>
<tr>
<td>Potassium</td>
<td>After two hours of (1)</td>
<td>5.48&lt;sup&gt;b&lt;/sup&gt;±0.13</td>
<td>5.06&lt;sup&gt;a&lt;/sup&gt;±0.10</td>
</tr>
<tr>
<td>(M Eq/Litre)</td>
<td>Two hours post (2)</td>
<td>5.75&lt;sup&gt;a&lt;/sup&gt;±0.11</td>
<td>6.25&lt;sup&gt;b&lt;/sup&gt;±0.09</td>
</tr>
</tbody>
</table>

Means superscripted by different letters and numbers differ significantly (p<0.05) among themselves. Alphabitical superscripts are for row comparison. Numerical superscripts are for column comparison.

Cellular K<sup>+</sup> and H<sup>+</sup> ions. This ameliorates extracellular alkalosis, but alkalinites the cell contents and depletes cellular K<sup>+</sup> which is excreted in urine.

Seasons had a significant effect on serum potassium at all the three intervals. In summer decreases in potassium were higher than in winter. The pre-exercise values for serum potassium in summer and winter were 6.66±0.02 and 6.17±0.12, respectively whereas corresponding figures after three hours of exercise were 5.06±0.10 and 5.48±0.13 which shows that there is significant decline in blood potassium content during exercise. These findings are contrary to the findings of Upadhyaya and Madan (1988) where loads had no effect on plasma potassium levels.

**Haematological parameters**

*Haemoglobin concentration:* Analysis of means for haemoglobin concentration presented in table 3 revealed that season had affected their concentration significantly. The average haemoglobin concentration (gm %) was 12.17±0.07, 12.40±0.15 and 12.14±0.08 during pre-exercise, three hours of continuous exercise and two hours post exercise, respectively. Further, it was observed that two hours rest was sufficient to restore the basal values. Present findings confirm the results of Georgie et al. (1970) and Gattewar (1983) but are not in agreement with Acharya et al. (1979).

Haemoglobin contents in the blood were higher in

Table 3. Means and their standard errors of different haemoglobin parameters in Hariana bullocks

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Season 1</th>
<th>Season 2</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haemoglobin Concentration (gm %)</td>
<td>Before exercise (0)</td>
<td>11.92&lt;sup&gt;a&lt;/sup&gt;±0.04</td>
<td>12.37&lt;sup&gt;ab&lt;/sup&gt;±0.08</td>
</tr>
<tr>
<td></td>
<td>After two hour of (1)</td>
<td>12.10&lt;sup&gt;a&lt;/sup&gt;±0.14</td>
<td>12.69&lt;sup&gt;ab&lt;/sup&gt;±0.17</td>
</tr>
<tr>
<td></td>
<td>Two hours post (2)</td>
<td>7.84&lt;sup&gt;a&lt;/sup&gt;±0.03</td>
<td>8.26&lt;sup&gt;b&lt;/sup&gt;±0.03</td>
</tr>
<tr>
<td>R.B.C Counts</td>
<td>Before exercise (0)</td>
<td>7.95&lt;sup&gt;a&lt;/sup&gt;±0.07</td>
<td>8.26&lt;sup&gt;b&lt;/sup&gt;±0.03</td>
</tr>
<tr>
<td></td>
<td>After two hour of (1)</td>
<td>7.95&lt;sup&gt;a&lt;/sup&gt;±0.07</td>
<td>8.38&lt;sup&gt;b&lt;/sup&gt;±0.13</td>
</tr>
<tr>
<td></td>
<td>Two hours post (2)</td>
<td>8.03&lt;sup&gt;a&lt;/sup&gt;±0.04</td>
<td>8.45&lt;sup&gt;b&lt;/sup&gt;±0.03</td>
</tr>
<tr>
<td>W.B.C Counts</td>
<td>Before exercise (0)</td>
<td>88700&lt;sup&gt;1a&lt;/sup&gt;±195.93</td>
<td>9538.00&lt;sup&gt;2b&lt;/sup&gt;±221.27</td>
</tr>
<tr>
<td></td>
<td>After two hour of (1)</td>
<td>9652.83&lt;sup&gt;2&lt;/sup&gt;±171.47</td>
<td>10751.71&lt;sup&gt;1&lt;/sup&gt;±199.26</td>
</tr>
<tr>
<td></td>
<td>Two hours post (2)</td>
<td>9119.87&lt;sup&gt;1a&lt;/sup&gt;±183.75</td>
<td>10025.87&lt;sup&gt;1b&lt;/sup&gt;±173.94</td>
</tr>
</tbody>
</table>

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summer than winter. Seasonal differences were noticed before the start of exercise, at exercise, and at rest. The haemoglobin contents increased due to exercise from 11.92±0.04 to 12.10±0.14, and from 12.377±0.08 to 12.69±0.17 in winter and summer seasons, respectively. This is not in agreement with the findings of Upadhyaya and Madan (1988) who reported reductions in haemoglobin content during continuous work in summer and winter seasons.

**RBC and WBC counts:** Averages and standard errors of R.B.C. and W.B.C. counts presented in table 3 indicated that season had significant effect. The overall means revealed that R.B.C. counts were higher (8.23±0.04) during post exercise, and W.B.C. counts were higher (10222.27±151.45) after two hours of exercise. The study also revealed that erythrocyte level can be restored to pre-exercise level after two hours of rest. Increase in TLC after work could have resulted from the evaporative loss of body water and the water loss in urination and defecation during work. Reduction in erythrocytes and increase in TLC in Hariana bullocks after exercise was also reported by Singh et al. (1968).

In summer erythrocytes and TLC were higher than in winter. Season had a significant effect on pre-exercise values of erythrocytes and TLC. After three hours of exercise erythrocytes and TLC increased in both seasons; this increase was not significant in RBC and was significant in TLC in summer only. For TLC two hours rest was sufficient to restore the basal values.

**CONCLUSIONS**

The results of the present study suggest that seasonal differences were significant. During winter season values at all the intervals were lower than in summer. After two hours post-exercise rest, Hariana bullocks regained their normal values for all the parameters except for pulse rate, respiration rate, rectal temperature and serum sodium during summer.

**ACKNOWLEDGEMENTS**

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