

Efficiency of Sustained Work and Its Influence on Physiological Responses in Young Bulls of Haryana Cattle

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ABSTRACT : Studies were carried out on forty young bulls of the Haryana breed (around 18 months of age) selected on the basis of their dam's milk yield at the animal farm of CCS HAU, Hisar during the period 1993-1999. Since animals showed variation in capacity to work over prolonged periods, they were subjected to regimes of carting without load and with 8 qtls. of load for three hours. The study revealed that maximum change took place in the pulse rate, followed by respiration rate and rectal temperature. The mean fatigue score for pulling an empty cart ranged between 1.66 to 2.20 after two hours work, and 2.36 to 2.73 after three hours work. For a cart loaded with 8 qtls., the corresponding ranges were 2.90 to 3.36 and 3.40 to 4.10, respectively. These results indicated that the animals under experiment had the capacity to pull moderate load (8 qtls.) for about two hours without showing any serious effect on the ability to recover and soon to work again. (*Asian-Aust. J. Anim. Sci.* 2001, Vol 14, No. 8 : 1062-1066)

Key Words : Draught, Physiological Responses, Haryana Breed.

INTRODUCTION

Draught animals still play an important role in some rural areas of the world; even with the present efforts of mechanization, it has not been possible to replace bullock power to any appreciable extent. According to Dayal (1982), 67 per cent of energy input in Indian farming enterprises comes from animal sources, 23 per cent from human exertion and the remaining 10 per cent from fossil fuels. Keeping in view the energy crisis, supply of petroleum products is short and their cost has accelerated. This problem is likely to increase in future and it is possible that oil may not be available for agricultural operations. Bullock power being an alternative source of energy is, therefore, a boon to the Indian economy, especially in the era of energy crisis. So, owing to their importance as draught animals, it is necessary to study their working efficiency and physiological responses during work.

MATERIALS AND METHODS

Animal selection

The present investigation was carried out on 40 young bulls of the Haryana breed selected, on the basis of their dam's milk yield at the two teeth stage (≤ 18 months), from the herd of the department of Animal Breeding, Haryana Agricultural University, Hisar during the period 1993-1999. These animals were related to the project "Genetic improvement of indigenous breeds of cattle (Haryana Unit)" being monitored and coordinated by Project Directorate on cattle, Meerut since 1987. These bulls were half sib progenies of sixteen sires. Prior to start of the experiment

these animals were trained for harness in a single bullock drawn cart. During the experimental period the animals were maintained under uniform managerial conditions.

Bullock cart

Single animal drawn pneumatic tyred bullock carts having an iron axle and ball bearings were modified for draught measurement.

Load selection

For testing optimum load, animals were individually subjected to a pull load of eight quintals. Since animals showed variations in capacity to work over prolonged periods, they were subjected to a regime of carting without load, and with eight quintals load for three hours or till fatigued. The exact load conditions for these tests were:

Load 1 : Animal hitched to a cart with man in cart
($0.30 \text{ t} + 0.07 \text{ t} = 0.37 \text{ tons}$)

Load 2 : Bullock cart loaded with 0.8 tons
($0.37 \text{ tons} + 0.80 \text{ tons} = 1.17 \text{ tons}$)

Animal fatigue

On the basis of physiological and behavioral manifestations, animals were given fatigue scores (table 1). Physiological reactions, namely rectal temperature, respiration rate, heart rate as well as animal excitability, leg incoordination, and appearance of froth and tongue protrusion were scored (Upadhaya and Madan, 1985). The total score consisted of 40 points; animals which attained a value of 20 or more were declared fatigued.

Experimental conditions

The work was carried out in the three major climatic conditions observed at Hisar in Northern India with three distinct periods of dry hot, dry humid, and winter weather.

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The work performance was tested under each of these periods for hot (S1) April to June, hot humid (S2) July to September and winter (S3) October to February. Days for experimentation within a period were selected so that a distinct climatic effect should impinge on the animal under different climatic periods and over different hours of work.

Draft animal power

Attributes relating to draft capacity were recorded for each male animal throughout the year. The animals were trained to pull a defined pneumatic wheel cart without and with 5 and 10 quintals loading conditions. The animals were put to continuous work for three hours and observations on physical and physiological responses were observed and recorded. The following observations at the beginning, during and after work were made:

Respiration rate per minute, pulse rate per minute, rectal temperature per minute, frothing, leg incoordination, excitement, inhibition of the progressive movement, tongue protrusion, and fatigue score.

Statistical methods

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

$$Y_{ijkl} = \mu + S_i + d_j + I_k + (SD)_{ij} + (SI)_{ik} + (DI)_{jk} + e_{ijkl}$$

where,

Y_{ijkl} = is the l^{th} observation in k^{th} interval at j^{th} draft level in i^{th} season

μ = overall mean

S_i = season effect

d_j = draft level effect

I_k = interval effect

$(SD)_{ij}$ = interaction of season and draft level.

$(SI)_{ik}$ = interaction of season and interval

$(DI)_{jk}$ = interaction of draft level and interval

e_{ijkl} = 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 found non – significant and the data were pooled for analysis of main effects as per Snedecor and Cochran (1968)

RESULTS AND DISCUSSION

Training of young bulls

Twenty young bulls were put to training for draft and it was seen that highest time taken by a young bull was 53 days for training and the lowest was 31 days. The study further revealed that on an average 35.8 ± 1.06 days were taken by them before they were ready for draft studies.

Draft studies

Means and standard errors of different physiological parameters while pulling empty and loaded carts in different seasons of the year at different intervals during work are presented in table 2.

Physiological parameter while pulling empty and loaded cart

Pulse Rate : Significant differences in pulse rate due to season of working was observed for all the three intervals i.e initial, and after two and three hours of continuous carting. The overall mean pulse rate was observed as 56.0 ± 0.7 per minute at initial stage while pulling an empty cart. In hot season (S1) the pulse rate was significantly higher than in the other two seasons. After two hours of

Table 1. Fatigue score card for young male animals

	Score				
	1	2	3	4	5
Pulse rate (min.)	Ho+10	Ho+20	Ho+30	Ho+40	Ho+50
Respiration rate (min.)	Ro+15	Ro+30	Ro+45	Ro+60	Ro+75
Rectal temp. (°C)	To+0.5	To+1.0	To+1.5	To+2.0	To+2.5
Frothing	First appearance	Dribbling of saliva start	Continuous dribbling	Appearance of froth on upper lip	Full mouth frothing
Leg incoordination	Stride uneven	Occasional dragging of fact	Movement of legs uncoordinated	No coordination in fore and hind legs	Unable to move due to incoordination
Excitement	Composed	Disturbed	Nostrils dilated and bad temperament	Movement of eye balls prominent with excitement	Furious and trying to stop
Inhibition of progressive movement	Brisk	Free movement	Slow walking	Very slow	Stop walking
Tongue protrusion	Mouth closed	Occasional opening of mouth	Frequent appearance of tongue	Continuous protrusion of tongue	Tongue fully out

Note: Ho, Ro and To represent initial pulse rate, respiration rate and rectal temperature, respectively.

Table 2. Means and standard errors of different physiological parameters at different intervals during works

Intervals		Empty cart			Cart with 8 qtls. Of load		
		Pulse rate (min.)	Respiration rate (min.)	Rectal temp. (°F)	Pulse rate (min.)	Respiration rate (min.)	Rectal temp (°F)
Initial	S1	58.0 ^b ±0.6	22.5 ^b ±0.2	102.0 ^b ±0.1	58.5 ^b ±0.5	23.0 ^b ±0.3	102.5 ^b ±0.2
	S2	55.5 ^a ±0.5	21.0 ^a ±0.3	100.0 ^a ±0.2	55.0 ^a ±0.6	21.5 ^{ab} ±0.4	100.5 ^a ±0.3
	S3	54.5 ^a ±0.7	20.0 ^a ±0.4	99.0 ^a ±0.2	54.0 ^a ±0.5	20.5 ^a ±0.5	100.0 ^a ±0.4
	Overall	56.0±0.7	21.0±0.3	100.0±0.1	55.0±0.7	21.5±0.5	100.8±0.1
After 2 hrs. of carting	S1	64.5 ^b ±0.8	25.5 ^b ±0.8	103.0 ^c ±0.2	70.5 ^b ±0.9	32.0 ^b ±1.6	102.6 ^b ±0.4
	S2	62.0 ^b ±0.6	23.0 ^{ab} ±0.7	101.5 ^b ±0.4	69.0 ^{ab} ±1.0	30.0 ^{ab} ±1.5	101.5 ^a ±0.4
	S3	56.0 ^a ±0.6	22.0 ^a ±0.9	100.5 ^a ±0.6	67.0 ^a ±1.2	28.5 ^a ±1.2	101.5 ^a ±0.2
	Overall	60.3±0.9	23.4±0.9	101.3±0.1	68.6±1.1	30.0±1.8	101.9±0.1
After 3 hrs. of carting	S1	66.5 ^b ±0.9	28.5 ^b ±2.0	103.5 ^b ±0.2	88.5 ^b ±3.0	45.0 ^b ±2.2	102.5 ^b ±0.1
	S2	65.0 ^{ab} ±1.2	26.0 ^{ab} ±1.8	102.0 ^a ±0.3	86.0 ^{ab} ±2.7	42.5 ^{ab} ±2.4	103.5 ^a ±0.3
	S3	63.0 ^a ±1.0	24.0 ^a ±1.9	101.0 ^a ±0.1	84.0 ^a ±2.0	41.5 ^a ±2.6	102.5 ^a ±0.2
	Overall	64.8±1.1	25.6±2.1	102.1±0.1	85.5±2.5	43.0±2.6	103.4±0.1

continuous carting the pulse rate was observed as 64.5±0.8 and the value reached a maximum at 66.5±0.9 per minute when the animal was put for three hours continuous carting. After two and three hours of continuous carting the difference between S1 and S2 was non-significant.

The mean values for pulse rate while pulling a cart with 8 qtls of load were 55.0±0.7, 68.6±1.1 and 85.5±2.5 per minute at initial stage, after two hours, and three hours of continuous carting. Hot season had significantly higher values for pulse rate than hot humid and winter season in these animals. The difference between S1 and S2 for pulse rate was not significant. The pulse rate was highest (88.5±3.0 per minute) during three hours of continuous carting in the hot season, and the lowest was 54.0±0.5 per minute during the winter season.

The present findings are in agreement with those reported by Acharya et al (1979), Satija (1983), Sree Kumar and Thomas (1990), Kumar (1991), Yadav et al (1997) and Yadav and Chopra (1999) in different breeds of dairy cattle.

The greater increase in pulse rate during work may be due to increased metabolic rate to provide more energy to muscles and to dissipate the extra heat load. Per cent increase in pulse rate at a particular load is an indicator of functioning capacity of cardiovascular system. Thus the pulse rate can be considered as a criterion for judging the working of the draught animals.

Respiration rate : Analysis of means for respiration rate presented in table 2 revealed a significant effect of season ($p < 0.05$) at all the three intervals. The overall means before commencement, after two hours and after three hours of continuous working were 21.0±0.3, 23.4±0.9 and 25.6±2.1 per minutes, respectively. During exercise, the respiration rate rose by 25.5±0.8 and 28.5±2.0 per minute after two and three hours continuous pulling empty cart. The difference between S1 and S2 was significant after two and three hours of continuous carting.

The animals pulling carts with 8 qtls of load showed the mean respiration rate as 21.5±0.5, 30.0±1.8 and 43.0±2.6 per minute for initial, after two, and three hours of continuous carting. The trend of seasonal differences during work was almost similar while pulling empty and loaded carts. The highest respiration rate was observed during S1 as 23.0±0.3 during initial, 32.0±1.6 after two hours, and 45.0±2.2 per minute after continuous work for three hours. The studies conducted by Maurya (1982), Rao and Upadhaya (1984), Kumar (1991), Yadav et al. (1997), and Yadav and Chopra (1999) with different breeds of cattle are in agreement with the present findings with haryana

Rectal temperature : Analysis of means for rectal temperature revealed a significant effect of ($p < 0.05$) of seasons on this parameter at all the intervals and draft levels. The overall means for rectal temperature were 100.0±0.1, 101.3±0.1 and 102.1±0.1°F at initial stage while pulling an empty cart, and after two and three hours continuous carting, respectively. Before commencement of exercise, the Haryana males had 1.5°F and 2.5°F higher temperature in the hot season than in the other two seasons. This difference is statistically significant. A similar trend was also observed during exercise.

The mean rectal temperature of animals while pulling a cart with 8 qtls. load was 100.8±0.1°F at initial stage, 101.9±0.1°F after two hours of carting, and 103.4±0.1°F after three hours of carting. The seasonal differences were higher during three hours of continuous carting as compared to initial stage and after two hours of continuous carting. The highest value for rectal temperature was observed as 105.0±0.1°F in the hot season after three hours of continuous carting. Similar increases in rectal temperature in summer than winter have been reported by Sastry et al. (1970), Acharya et al. (1979), Agarwal et al. (1982), Kumar (1991) and Yadav et al. (1997) in different breeds of cattle. Increase in body temperature during exercise might be

attributed to heat production as a result of muscle contraction during work. This was measured as an index of the animal's capacity, beyond which it shows erratic expression in behavior and appearance.

Fatigue Score : In terms of physiological responses scored throughout the year as change in pulse rate, respiration rate and rectal temperature when animals were tried on cart without load and with 8 quintals of load, at the start, 2, and 3 h after the start of the experiment, maximum changes took place in the pulse rate score (1.73 to 3.66) and rectal temperature (1.86 to 4.00). The study also revealed (table 3) that with a loaded cart after 3 hours of work the increases were maximum for all three parameters. The physical parameters measured on animals as intensity of frothing, leg incoordination, excitement and progressive movement and tongue protrusion showed maximum fluctuation in frothing score as 1.83 to 2.73 while pulling an empty cart, and in leg incoordination as 3.00 to 4.10 while pulling loaded cart. The mean fatigue score for empty cart was ranging between 1.66 to 2.20 after two hours work, and 2.36 to 2.73 after three hours work. In case of cart with eight quintals load, the corresponding ranges were 2.90 to 3.36, and 3.40 to 4.10, respectively.

All these physiological and physical adjustments during heavy work load particularly during summer are associated with increased metabolism in order to provide adequate energy to the working muscles and to dissipate extra heat. The body temperatures attained by animals during work were influenced by the ambient conditions. A large temperature rise during work has been described as physiologically necessary to increase the rate of chemical processes, to change internal frictional resistance in muscles and to enhance supply of oxygen to the working muscles (Astrand and Rodhal, 1970). The availability of oxygen and energy substrates, and obtaining an optimum chemical milieu at the cellular level become limiting factors for work. Upadhaya and Madan (1985) observed similar results in

crossbred and Haryana bullocks.

CONCLUSIONS

These results indicated that the animals under experiment had the capacity to pull a moderate load (8 quintals) for about two hours without showing any serious effect on the ability to recover and soon to work again. All these physiological and physical adjustments during heavy work load particularly during summer are associated with increased metabolism in order to provide adequate energy to the working muscles and to dissipate extra heat.

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Table 3. Mean fatigue scores for physiological and physical parameters after two and three hours of carting

Parameters	Empty cart		Cart with 8 qtls. of load	
	A	B	A	B
Pulse rate (min.)	1.66	2.46	3.23	3.83
Respiration rate (min.)	1.73	2.93	3.26	3.66
Rectal temp. (°F)	1.86	2.36	3.36	4.00
Frothing	1.83	2.73	3.20	4.03
Leg incoordination	1.96	2.50	3.00	4.10
Excitement	1.83	2.40	2.90	4.00
Inhibition of progressive movement	1.93	2.56	3.06	3.70
Tongue protrusion	2.20	2.40	3.03	3.40

A=After 2 hours of carting. B=After 3 hours of carting.

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