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Studies on changes in physiological parameters of red Kandhari and Khillar bullocks during sugarcane carting operation

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Abstract
The sugar industry of Maharashtra is providing direct and indirect employment in the rural sector. Transportation of sugarcane from field to factory. Red Kandhari bullocks and to some extent Khillar bullocks are among the draught animal is the main animal power source for sugarcane transportation. The present work was planned at the RKRI,COVAS, MAFSU Parbhani and the field trials were also taken at Yogeshwari Sugar Factory Pvt. Ltd., At- Limba, Ta- Pathri, Dist- Parbhani. Each trial was repeated for 3 consecutive days and sugarcane carting operation at each load and road was carried out for one hour, cumulatively four and half hours of work from 9.00 to 2.00 hours was carried out during the experimental period. The two bullock pairs of Red Kandhari and Khillar with uniform age group, body weight and body size and were selected and used for sugarcane carting operation. Sugarcane carting trials were conducted with iron bullock cart with pneumatic tyres at various road conditions i.e. Field road (R1 from sugarcane field upto road), Katcha road (R2 from the end of field road upto the start of tar road) and tar road (R3 from the start of tar road to factory) by providing rest of half an hour at each road condition with various load conditions i.e. 2.5 (L1), 2.0 (L2), 1.5 (L3) and 1.0 ton (L4) of sugarcane and observations were compared with each other. The physiological parameters i.e. respiration rate, pulse rate and rectal temperature increases as there is increase in load and decreasing the road condition. The linear increase in the physiological responses of Red Kandhari and Khillar bullocks carting from field to katcha and tar road conditions may be due to the cumulative effect of carting exercise with insufficient resting period to bring back the physiology to the normal condition.

Keywords: Khillar, Red Kandhari, carting, katcha road, field road, physiological

1. Introduction
The Agriculture operations in India are mainly dependent on bullock power. Animal is a significant and major power source for agriculture operations, though mechanization has been introduced in some parts of the country, yet small and marginal farmers depend on the bullocks for their most field operations. The term draught refers to an act of moving load by drawing or force required to pull an implement. The draught power of animals has remained a pivotal force in developing countries like India. India is the world's largest sugar producer and Maharashtra is the country's second largest sugar producing state contributing over one-third of the country's output. The majority of sugarcane cutter labourers transport sugarcane with their carts or carts supplied by the sugar factory. The bullock carts used for sugarcane transportation are all pneumatic tyred carts. The majority of the bullock pairs used for hauling sugarcane from field to factory belongs to the Khillar breed, which is a well-known draft breed of India. Similarly, the marathwada region very few sugarcane cutters use the other draft breed in which Red Kandhari being the most popular. The Indian sugar industry completed the sugar season 2019-20 producing 27.5 MT of sugar as against 33.16 MT produced in the year 2018-19. We might see a bumper production in the season 2020-21 to the tune of 32 MT of sugar production because of favorable monsoon and increase in sugarcane area in key sugar producing states of Maharashtra, Karnataka and Tamil Nadu. Total 460 sugar mills were in operation in the country and have produced 73.77 lac tons of sugar while in Maharashtra, 173 sugar mills are in operation and they have produced sugar 26.96 lac tons as on December 15, 2020 as reported by ISMA. (Publication of Vasantdada Sugar Institute, Oct-Dec 2020) [5]. Hence, an attempt was made in the present research study the impact of draft work on the physiological and haematological parameters on Red Kandhari and Khillar bullocks at varying payloads, road condition, type of cart and speed.

2. Materials & Methods

The present research work was undertaken on the Red Kandhari research and instructional farm, college of veterinary and animal Sciences, MAFSU Parbhani and the field trials were taken at Yogeshwari Sugar Factory Pvt. Ltd. at Limba Tq- Pathri Dist- Parbhani for three (03) consecutive days. Two pairs of Red Kandhari bullocks and two pairs of Khillar bullocks with the same age, body weight and body measurements i.e. body length, chest girth and height were selected from the sugarcane cutter labourers of Yogeshwari Sugar Factory Pvt.

Ltd. at Limba Tq- Pathri Dist- Parbhani. The same two pairs of bullocks were used for all the carting trials in the field. The pairing of bullocks was done at the time of their selection with a minimum difference in age, body weight and body measurements. All the experimental animals were housed in the open field temporary thatched houses with changing fields for maintaining hygienic conditions and were subjected to the same type of environment. Feeding and management practices were the same for all the animals. They were offered an ad-libitum quantity of dry and green forages and locally available concentrate mixture as maintenance ration @ 2 kg/animal/day during the period of operation. Sugarcane carting trials were conducted with iron bullock cart with pneumatic tyres for Red Kandhari and Khillar bullocks at various road conditions i.e. Field road (R_1) (from sugarcane field upto road), Katcha road (R_2) (from the end of field road upto the start of tar road) and tar road (R_3) (from start of the tar road to factory) by providing rest of half an hour at each road condition with various load conditions i.e. 2.5 ton (L_1), 2.0 ton (L_2), 1.5 ton (L_3), 1.0 ton (L_4) of sugarcane excluding the weight of carts and cartman. The working hours of bullocks for research work were 09.00 to 14.00 hours. Two common Iron cart with pneumatic tyres were used on tar, katcha and field road for both the breeds of bullock pairs i.e. Red Kandhari and Khillar. The weight of the cart was 515 kg and the weight of the cartmen was 60 kg. The sugarcane was loaded into the cart for increasing or decreasing the payload.

The physiological observations were recorded according to the standard clinical procedures every day before the start of each road and load condition carting trial of sugarcane and immediately after the completion of each road condition during carting operation.

i. Pulse rate (Counts per minute)

The pulse rate was recorded by feeling the pulsation of coccygeal artery for one minute. The observation was repeated three times to rule out any error in the pulse rate and the average of three observations was considered for the study. This observation was also recorded before and after the completion of carting on each road condition for each load condition, each day for consecutively 3 days.

ii. Respiration rate (Counts per minute)

The respiration rate was noted by counting the gushes of respired air at the back of the palm kept near the nostrils of the bullocks for one minute and similarly repeated three times to come to a correct average. The respiration rate was also recorded before and after the completion of caring for each road condition and each load condition, each day for consecutively 3 days.

iii. Body temperature (^{0}F)

The body temperature was recorded with the digital clinical thermometer by inserting in into the animals rectum for one minute. The care was taken at the time of recording that the bulb of thermometer touches the mucosa of the rectum. The body temperature was recorded before and after the completion of carting of each road condition and each load condition, each day for consecutively 3 days.

2.1 Statistical Analysis

The data on various parameters as recorded under physiological parameters i.e. respiration rate, pulse rate and rectal temperature and haematological parameters i.e. Hb, PCV, RBC, WBC and blood glucose were analyzed using CRD model of Statistical Analysis as mentioned by Panse and Sukhatme (1967) [4].

3. Results & Discussion

The overall mean values for a pulse rate of Red Kandhari and Khillar bullocks before and after a trial at field road, katcha road and tar road and at 2.5,2,1.5 and 1 ton load is depicted in table1.

The analysis of variance has revealed highly significant (P<0.01) differences of Red Kandhari bullocks for before and after and for before pulse rate of Khillar except the pulse rate observed after the carting operation where in it was significantly (P<0.05) differences during the sugarcane carting load of 2.5 ton operation. Similarly, all the differences for before and after pulse rate observed in the Red Kandhari and Khillar has exhibited highly significant (P<0.01) differences for sugarcane carting load of 2 ton. In the case of sugarcane carting operation of 1.5 ton load the highly significant (P<0.01) differences were observed in both the breeds for before and after pulse rate recorded except for the differences observed for a pulse rate of before carting operation in Khillar wherein it was significantly (P<0.05) differed. The highly significant (P<0.01) differences were observed for the pulse rate of before and after sugarcane carting operation for a payload of 1 ton for both breeds as revealed by the analysis of variance.

These findings are confirmation with those reported by, Acharya *et al*. (1979) [1] for indigenous bullocks, and Upadhyay (1984) [6] for crossbred during ploughing, Yawlikar (2001) [8] for ploughing, sowing and carting operations for Red Kandhari, Deoni and crossbred bullocks, Kataktalware *et al*. (2008) [3] in yak, Shelke and Siddiqui (2009) [7] for carting operation in Red Kandhari and Atkare and Siddiqui (2009) [2] for Deoni bullocks, respectively.

The overall mean values for respiration rate of Red Kandhari and Khillar bullocks before and after trial at field road, katcha road and tar road and at 2.5,2,1.5 and 1 ton load is depicted in table 3.

The overall mean values for respiration rate before and after trial at field, katcha and tar road and at 2.5,2,1.5 and 1 ton load of Red Kandhari and Khillar bullocks is given in table 3.

The analysis of variance has revealed highly significant (P<0.01) differences for respiration rate of Red Kandhari for before and after and for Khillar before whereas significant for after the sugarcane carting operation at the payload of 2.5 ton. Similarly, the highly significant (P<0.01) differences were observed for Red Kandhari and Khillar in the respiration rate before carting operation whereas only significant (P<0.05) differences were observed in respiration rate for after the carting operation in both the breeds at load L_2 (2.0 ton). The highly significant (P<0.01) differences in respiration rate of Red Kandhari and Khillar breed before and after carting

operation for L_3 (1.5 ton) load were observed. Similar observations were also recorded for L_4 (1.0 ton) load.

These findings are in agreement with those reported by Acharya *et al*. (1979) [1] for indigenous cattle, Rao and Upadhyaya (1984) [6] for crossbred at ploughing, Yawlikar (2001) [8] for Red Kandhari, Deoni and crossbred at ploughing and carting, Kataktalware *et al*. (2008) [3] in yak for carting, Shelke and Siddiqui (2009) [7] for Red Kandhari at carting, Atkare and Siddiqui (2009) [2] for Deoni at carting operation. The similar trend of increasing respiration with increased load/ draft and at different road conditions confirm the present findings.

The overall mean values for rectal temperature of Red Kandhari and Khillar bullocks before and after trial at field road, katcha road and tar road and at 2.5,2,1.5 and 1 ton load of Red Kandhari and Khillar bullocks is shown in table 5.

The analysis of variance has revealed highly significant (P<0.01) differences for the rectal temperature for after the sugarcane carting in Red Kandhari, for before and after in Khillar, whereas only significant (P<0.05) differences for before sugarcane carting in Red Kandhari for 2.5 ton (L_1) load. The highly significant (P<0.01) differences in rectal temperature for before and after in Red Kandhari whereas only significant (P<0.05) differences for before and after in Khillar breed were observed for sugarcane carting operation with payload of 2 ton (L_2) similarly highly significant differences (P<0.01) in the rectal temperature for before and after sugarcane carting operation for 1.5 ton (L_3) and 1.0 ton (L_4) were revealed by the analysis of variance for both Red Kandhari and Khillar breeds except significant differences (P<0.05) in before carting operation by Khillar breed at 2 ton (L_3 load).

The increase in the body temperature after the different payloads and roads during sugarcane carting observed in the present study is in consonance with the findings reported by Acharya *et al*. (1979) [1] for indigenous, Rao and Upadhyay (1984) [6] for crossbred, Yawlikar (2001) [8] for Red Kandhari, Deoni and HF crossbred, Kataktalware *et al*. (2008) [3] for yak, Shelke and Siddiqui (2009) [7] for Red Kandhari and Atkare and Siddiqui (2009) [2] for Deoni bullocks during carting operation.

Table 1: The overall mean values of Pulse Rate/minute before and after trial of Red Kandhari and Khillar bullock pairs at different payloads and roads during sugarcane carting operation for three consecutive days.

Breeds / Treatments	Red Kandhari		Khillar	
	Overall mean		Overall mean	
	Before	After	Before	After
L_1(2.5 Ton)				
R_1	54.00^c	62.00^c	51.00^c	62.00^c
R_2	57.33^b	66.00^b	55.00^b	66.00^b
R_3	60.33^a	74.33^a	59.66^a	76.33^a
Grand Mean	57.22	67.44	55.22	68.11
SE±	0.1	0.08	0.2	0.1
CD	0.7	0.35	0.9	0.7
L_2 (2.0 Ton)				
R_1	52.67^c	63.33^c	52.66^c	61.28^c
R_2	57.00^b	69.66^b	55.67^b	67.00^b
R_3	61.00^a	72.66^a	59.31^a	72.33^a
Grand Mean	56.89	68.55	55.88	66.87
SE±	0.1	0.2	0.1	0.1
CD	0.5	0.98	0.5	0.6
L_3 (1.5 Ton)				
R_1	55.00^b	66.00^c	53.66^c	62.66^c
R_2	60.00^a	70.33^b	56.67^b	67.33^b
R_3	60.00^a	73.33^a	60.00^a	73.33^a
Grand Mean	58.33	69.88	56.78	67.77
SE±	0.1	0.2	0.3	0.1
CD	0.6	0.83	1.20	0.4
L_4 (1.0 Ton)				
R_1	50.00^c	63.67^c	49.67^c	64.66^c
R_2	54.66^b	67.33^b	55.66^b	68.66^b
R_3	60.00^a	71.66^a	60.00^a	73.00^a
Grand Mean	54.88	67.55	55.11	68.77
SE±	0.3	0.1	0.2	0.1
CD	1.23	0.4	0.96	0.7

Note: Means connected with similar superscript in each column do not differ significantly from each other

Table 2: Analysis of variance of Pulse Rate (per/min) before and after of Red Kandhari and Khillar bullock pairs at different payloads and roads during sugarcane carting operation for three consecutive days.

Source	df	Red Kandhari				Khillar			
		Before		After		Before		After	
		MSS	F value	MSS	F value	MSS	F value	MSS	F value
L_1 (2.5 Ton)									
Road	2	2.01	44.16**	7.92	621.24**	3.76	47.80**	1.09	23.50*
Error	3	0.04		0.01		0.08		0.05	
L_2 (2.0 Ton)									
Road	2	3.47	154.05**	4.54	47.37**	2.21	100.28**	6.10	175.60**
Error	3	0.02		0.1		0.02		0.03	
L_3 (1.5 Ton)									
Road	2	1.67	47.61**	2.72	39.13**	2.00	14.08*	5.72	352.13**
Error	3	0.3		0.07		0.1		0.02	
L_4 (1.0 Ton)									
Road	2	5.00	32.92**	3.20	194.35**	5.38	58.27**	3.47	69.2**
Error	3	0.1		0.02		0.1		0.05	

*P< 0.05 ** P< 0.01

Table 3: The overall mean Respiration Rate /min before and after of Red Kandhari and Khillar bullock pairs at different payloads and roads during sugarcane carting operation for three consecutive days.

Breeds / Treatments	Red Kandhari		Khillar	
	Overall mean		Overall mean	
	Before	After	Before	After
L_1 (2.5 Ton)				
R_1	19.33^c	49.00^c	18.00^c	42.66^c
R_2	22.67^b	58.00^b	21.33^b	51.33^b
R_3	23.66^a	71.67^a	22.33^a	62.66^a
Grand Mean	21.88	59.56	20.55	52.22
SE±	0.08	0.09	0.07	0.23
CD	0.4	0.4	0.33	1.05
L_2 (2.0 Ton)				
R_1	18.66^b	39.00^c	17.66^c	38.00^c
R_2	21.67^a	49.66^b	19.33^b	44.00^b
R_3	22.00^a	57.00^a	21.00^a	53.00^a
Grand Mean	20.78	48.55	19.33	45.00
SE±	0.1	0.3	0.06	0.2
CD	0.5	1.18	0.28	0.86
L_3 (1.5 Ton)				
R_1	18.33^c	40.00^c	17.00^c	35.33^c
R_2	20.67^b	43.66^b	18.00^b	38.00^b
R_3	22.33^a	51.67^a	20.33^a	49.00^a
Grand Mean	20.44	45.11	18.44	40.77
SE±	0.08	0.11	0.10	0.4
CD	0.4	0.51	0.47	1.78
L_4 (1.0 Ton)				
R_1	18.33^b	35.33^c	16.33^c	31.66^c
R_2	20.00^a	40.33^b	18.33^b	36.00^b
R_3	20.50^a	47.67^a	19.66^a	42.67^a
Grand Mean	19.61	41.11	18.11	36.78
SE±	0.1	0.14	0.03	0.08
CD	0.5	0.64	0.1	0.4

Note: Means connected with similar superscript in each column do not differ significantly from each other.

Table: 4: Analysis of variance of Respiration Rate /min before and after of Red Kandhari and Khillar bullock pairs at different payloads and roads during sugarcane carting operation for three consecutive days.

Source	df	Red Kandhari				Khillar			
		Before		After		Before		After	
		MSS	F value	MSS	F value	MSS	F value	MSS	F value
L_1 (2.5 Ton)									
Road	2	1.031	72.88**	2.60	173.74**	1.03	95.79**	2.01	18.32*
Error	3	0.01		0.01		0.01		0.1	
L_2 (2.0 Ton)									
Road	2	6.75	225**	1.64	11.87*	5.56	687.96**	1.14	15.44*
Error	3	0.03		0.1		0.008		0.07	
L_3 (1.5 Ton)									
Road	2	8.10	572.15**	7.13	276.00**	5.86	266.1**	10.49	33.35**
Error	3	0.01		0.02		0.02		0.3	
L_4 (1.0 Ton)									
Road	2	2.57	93.50**	7.70	191.34**	5.62	2293.5**	6.15	449.18**
Error	3	0.03		0.04		0.002		0.3	

*P< 0.05 ** P< 0.01

Table 5: The overall mean values of Rectal Temperature ºF before and after trial of Red Kandhari and Khillar bullock pairs at different payloads and roads during sugarcane carting operation for three consecutive days.

Breeds / Treatments	Red Kandhari		Khillar	
	Overall mean		Overall mean	
	Before	After	Before	After
L_1 (2.5 Ton)				
R_1	100.55^b	101.27^b	100.51^c	101.37^c
R_2	100.90^a	101.58^b	100.99^b	101.83^b
R_3	101.18^a	102.62^a	101.45^a	102.75^a
Grand Mean	100.88	101.82	100.98	101.98
SE±	0.15	0.1	0.05	0.1
CD	0.70	0.5	0.2	0.4
L_2 (2.0 Ton)				
R_1	100.34^c	101.00^c	100.39^b	100.99^c
R_2	100.64^b	101.44^b	100.61^b	101.55^b
R_3	101.01^a	102.16^a	101.10^a	102.57^a
Grand Mean	100.66	101.53	100.70	101.70
SE±	0.1	0.06	0.08	0.05
CD	0.6	0.3	0.3	0.2
L_3 (1.5 Ton)				
R_1	100.12^c	101.13^c	100.30^b	101.32^c
R_2	100.44^b	101.53^b	100.78^a	101.74^b
R_3	100.77^a	102.35^a	101.23^a	102.47^a
Grand Mean	100.44	101.67	100.77	101.84
SE±	0.04	0.06	0.1	0.04
CD	0.2	0.3	0.5	0.2
L_4 (1.0 Ton)				
R_1	100.28^c	101.15^c	100.08^c	100.88^c
R_2	100.70^b	101.55^b	100.61^b	101.52^b
R_3	101.15^a	102.39^a	101.06^a	102.63^a
Grand Mean	100.71	101.69	100.59	101.68
SE±	0.06	0.07	0.05	0.06
CD	0.3	0.3	0.2	0.3

Note: Means connected with similar superscript in each column do not differ significantly from each other.

Table 6: Analysis for variance of the overall mean values of Rectal Temperature before and after trial of Red Kandhari and Khillar bullock pairs at different payloads and roads during sugarcane carting operation for three consecutive days.

Source	df	Red Kandhari				Khillar			
		Before		After		Before		After	
		MSS	F value	MSS	F value	MSS	F value	MSS	F value
L_1 (2.5 Ton)									
Road	2	0.60	12.42*	0.99	45.72**	0.43	95.72**	0.99	58.16**
Error	3	0.05		0.02		0.004		0.02	
L_2 (2.0 Ton)									
Road	2	0.43	114.40**	0.7	100.45**	0.3	22.90*	1.3	27.55*
Error	3	0.04		0.007		0.01		0.005	
L_3 (1.5 Ton)									
Road	2	0.21	73.29**	0.8	109.02**	0.43	19.42*	0.7	179.00**
Error	3	0.003		0.007		0.02		0.004	
L_4 (1.0 Ton)									
Road	2	0.4	52.84**	0.8	79.28**	0.5	82.42**	1.57	213.83**
Error	3	0.007		0.01		0.006		0.007	

*P< 0.05 ** P< 0.01

4. Conclusion

It can be concluded that the Red Kandhari and Khillar bullocks were exposed to all such types of draught operations for centuries together and hence might have developed capacity, stamina and draught abilities in a novel manner to prove them as the most ideal and suitable draught animals of this region. The linear increase in the physiological responses of Red Kandhari and Khillar bullocks during carting from field to katcha and tar road conditions may be due to the cummulative effect of carting exercise with insufficient resting period to bring back the physiology to the normal condition and may suggest future research work to decide sufficient resting period to be given to the bullock pairs.

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