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Performance and Welfare Status of Working Donkeys

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Abstract: In Africa, donkeys have significant contribution in traction operation, but there is little research related to workload and their welfare. The objective of this work was to examine the effect of various loads on donkeys' physiological and behavioural responses to evaluate welfare. Donkeys weighing of 132-172 kg (159 ± 11 kg) and totally 20 were used for the experiment. The experimental design included two wheeled cart × seven load class (an increment of 100 kg) with five repetitions each, and the travelled distance was 2 km. Travelled time, behavioural occurrences and physiological responses were recorded. Statistical analysis was conducted using SAS (version 9.4) software programme. When loads were 500-700 kg, heavy and rapid panting and falling down occurred frequently. When loads increased successively and reached 500, 600 and 700 kg, speed started declining from 3.68 km/h to 3.5, 2.94 and 2.54 km/h, respectively, indicating that speed and applied loads are inversely correlated ($P < 0.001$). Heart rate was 129 ± 11 bpm at 700 kg, and in respect to resting state, donkeys' heart rate elevated by a factor of up to 3. As the load exceeded 400 kg, the speed declined significantly, and behavioural occurrences like heavy panting and falling down confirmed this. This leads to the conclusion that donkeys could pull about 2.7 times of their live weight. But if they have continuous and long working hours (about 6 h), it is recommended to keep load of two wheeled cart about double of donkeys live weight so as to safe guard donkeys' welfare.

Key words: Donkey, load, behaviour, heart rate, welfare.

1. Introduction

The estimate world donkey population has steadily increased from 37 million in 1961 to 44 million in 1996, but it is not evenly distributed around the world with most donkeys occurring in semi-arid and mountainous areas. In Africa, in the last fifty years (1949-1996), donkey population has increased from 8.5 million to 13.7 million [1]. The great majority of donkeys in the world are kept specifically for work. Their most common role is for transport, whether riding, pack transport or pulling carts. They may also be used for farm tillage. In certain countries, they may assist threshing, raising water, milling or other operations [2].

In most of Africa, animal power is being used to replace or supplement for human power, and this trend is continuing in most of the continent. With so many agricultural and transport tasks performed by humans, there is much scope for continued expansion. In many countries, women use donkeys for pack transport and sometimes for riding [3]. In Africa, while motorized transport has been thriving rapidly since the 20th century, the use of animal power for local transport has not experienced a proportionate decline [4]. Donkeys are preferred as draught and transport animals, because they are friendly, hardy, quiet and more economical, compared to horses and oxen. They can be maintained on local farm produce, and are easy to train, intelligent and patient while working [5]. These characteristics make donkey a likely choice for many children and women to use in developing countries [6].

Donkeys as pack animals can carry a load that is up to 100 kg or that is 50% of their body weight [7]. It has also been reported that donkeys can carry heavy loads twice of the weight that a person can carry for a longer distance [8]. As donkeys become a more popular choice of work animals for small-holder

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farmers, specific management practices need to be devised in order to fully maximize their natural survival advantages [9].

The improvement in health and welfare will enhance their productivity and provide their owners with a more reliable source of income [10]. Improper housing and handling expose donkeys to wounds and lead to poor performance. Donkeys are exposed to wound infections mostly during the hot-dry and rainy seasons [11]. Various welfare issues have been reported in working donkeys elsewhere in Africa. Long working hours, harsh environmental conditions, over-use, improper equipment, limited veterinary attention and little or poor quality supplementary feed during dry periods can lead to welfare problems [12-15].

Changes in heart rate, breathing rate and temperature are the most important physiological responses to work and can be measured on working animals without causing them too much discomfort [16, 17].

It is difficult to measure welfare and feelings of an animal. However, it is possible to get some indication of what the animal is feeling by indirect means through its physiological and behavioural responses. Behaviour is the expression of an animal's perception and interaction with its environment [18, 19].

Despite the large donkey population and significant contribution in traction operation, little research has focused on donkey in respect to workload and the related stress that would contribute to improving welfare and efficiency. Thus, the main objective of this work was to study the effect of various loads on donkeys' physiological and behavioural responses to evaluate welfare during work.

2. Materials and Methods

2.1 Animals and Loads

The field experiment was conducted in the outskirt of Nairobi during the long rainy season in April. During this month, the average rainfall was 130 mm and temperature varied between 15 °C and 25 °C, whereas relative humidity was around 60%. Donkeys weighing between 132 kg and 172 kg with mean weight 159 ± 11 kg were used for the field experiment and the total number of animals was 20. The donkeys were subjected to pulling two wheeled carts having varying loads.

The loads successively increased by 100 kg from 100 kg to 700 kg forming seven load groups. Therefore, the experimental design included two wheeled cart × seven load class with five repetitions each. Travelled distance was 2 km for all field measurements. In order to avoid heat stress, the measurements were performed at 08:00 and 16:00 local time.

2.2 Behavioural Observation

When the animals were pulling various loads to comprehensively monitor the effect of loads on donkeys' welfare, the behavioural occurrences were recorded as stress related to work. Time required to cover the distance of loaded donkeys was also measured.

2.3 Heart Rate Measurement

Heart rate measurement was used as a physiological response when animals were pulling loads. Measurement was also taken on donkeys (without any load) at resting state to serve as control group. Wireless heart beat sensor consisting of two main components—transmitter and wrist receiver [20] was used to measure heart rate. The sensor transmits heart beats of animals to the receiver. The transmitter was attached to an adjustable strap before mounting on the animals. To develop contact between the skin and the transmitter, the band should be moisten before fitting. To further facilitate contact and avoid interruption, a gel (Lectro Derm) was used on the belt and skin of the animals. The heart rate signals transmit usually telemetrically within a range of 1 m to the receiver, which was safely attached to the strap. The receiver had five sampling intervals: manual, R-R (beat to

beat), 5 s, 15 s and 60 s. Selection of intervals is chosen in a way that the memory could be utilized effectively. In this measurement, the receiver was set to 5 s intervals. The data stored in the receiver usually upload with PC interface unit. Heart beat sensors were mounted on the animals immediately before the start of loading to record the heart rate variations and dismounted after the trip is completed.

2.4 Data Analysis

The heart beat data stored in the receiver were uploaded with PC interference unit for analysis. Statistical analysis was conducted using SAS (version 9.4) software PC based programme. Analysis of variance (MANOVA), general linear model and regression analysis were used for data processing.

3. Results

Behavioural, physiological parameters and speed of working animals were the main responses used to evaluate their welfare.

3.1 Behavioural Responses

During pulling carts of various loads, some of the behaviours that most frequently occurred are illustrated in Table 1. The behaviours were load dependent and grossly fell into two main categories. When the loads were between 500 kg and 700 kg, heavy and rapid panting, refuse to move forward and falling down were the behaviours that occurred mostly.

3.2 Speed Versus Loads

Animals' speeds and loads are illustrated in Fig. 1. It could be noted that speeds of donkeys were strongly influenced by the applied loads. When the load increased from 100 kg to 200 kg, the average speed remained almost unchanged. As the loads increased to 300, 400 and 500 kg, the corresponding mean speeds were 3.68, 3.58 and 3.5 km/h, respectively, denoting slow decline.

The speed further declined to 2.94 km/h and 2.54 km/h when the loads changed to 600 kg and 700 kg, respectively. In this case, the speed decreased sharply and indicates that donkeys speed and the load applied to them are inversely correlated ($P < 0.001$). A polynomial function having the order of four fits well ($R^2 = 0.78$) to the points.

Table 1 Load ranges and behavioural responses of working donkeys.

Load range (kg)	Occurred behaviours
100-500	Aggressiveness, defecation, ear erecting, tail wagging, smelling and moving backward
500-700	Heavy and rapid panting, refuse moving forward and falling down

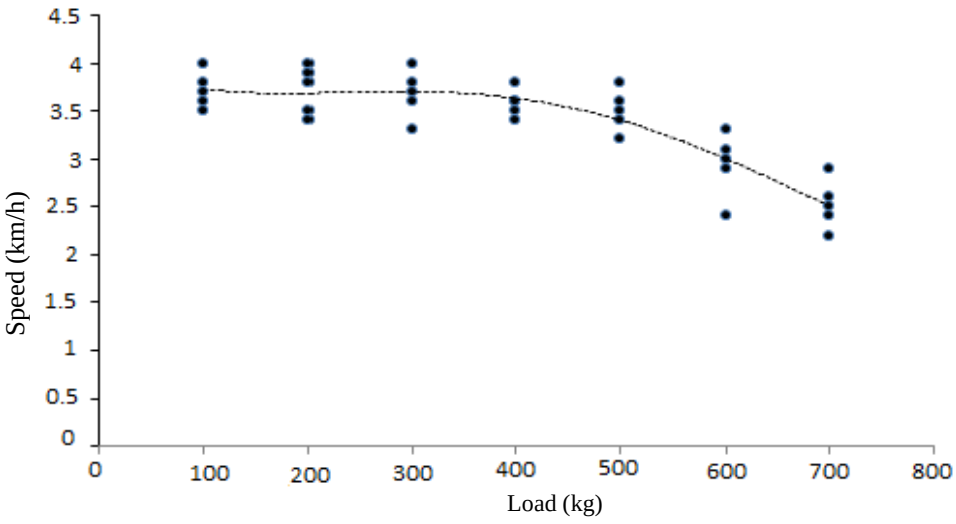

Fig. 1 Speed variation versus applied loads.

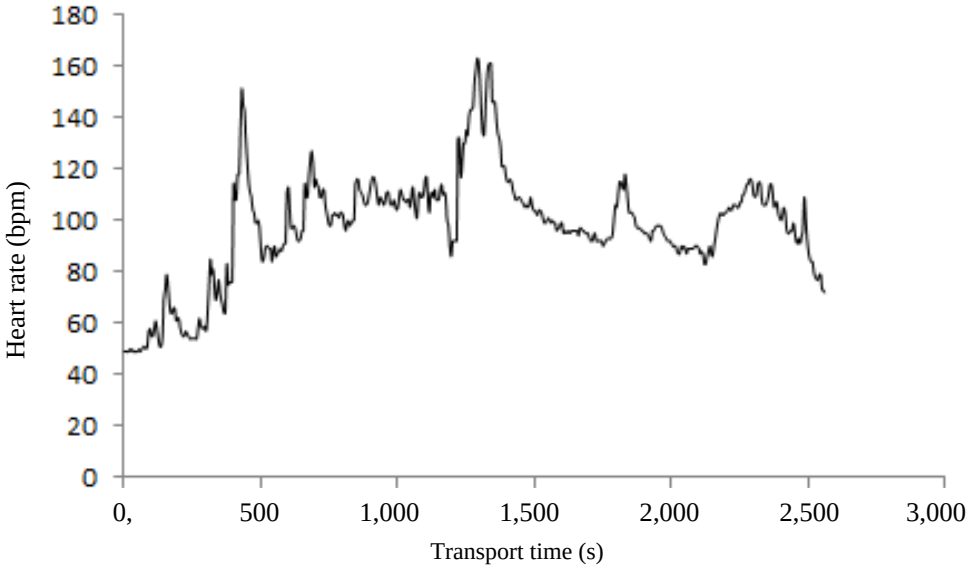

Fig. 2 Heart rate profile of donkey pulling two wheeled loaded cart.

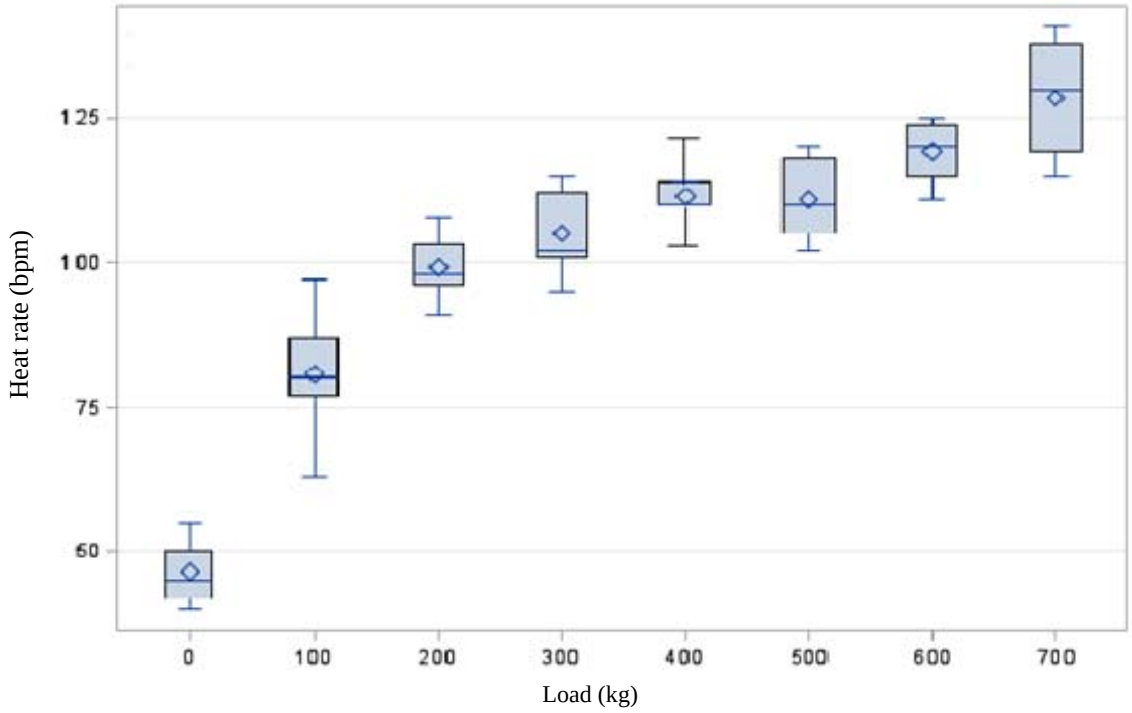

Fig. 3 Heart rate performances against various loads.

3.3 Dynamic Heart Rate Profile

Representative heart rate profile of donkey while pulling loaded carts is presented in Fig. 2. The donkey body weight was 154 kg and pulled a cart having a load of 400 kg for about 42 min.

Rapid heart rate elevation was recorded shortly after resting state (49 bpm). It reached a peak of 151 bpm as a physiological response to the load, and this stage required about 7 min. Thereafter, the pulse rate varied between 85 bpm and 162 bpm, with occasional peaks but fairly steady state with a mean of 100 bpm, and it consisted around 77.5% of the operation time. During unloading, heart rate of the animal started declining sharply from 109 bpm to 72 bpm, but it

would require some time to recover and reach the original resting state.

3.4 Pulling Loads and Heart Rate Responses

Heart rate growth against loads of working donkeys is illustrated in Fig. 3. There were various animal loads and heart rate responses, including a control group without any load. The heart rate mean at rest state is 46 ± 6 bpm. The mean heart rate of loaded (100 kg) animals was 81 ± 12 bpm and 99 ± 6 bpm as the load increased to 200 kg. It further elevated to 105 ± 8 bpm as the load increased to 300 kg. In this way, the heart rate kept on growing as the load increased by every 100 kg until the maximum load (700 kg), and the corresponding heart rate was 129 ± 11 bpm. The results demonstrated that there was strong correlation between load and heart rate growth ($P < 0.001$). Moreover, the heart rate growth against load could be best described by a polynomial function of an order three ($R^2 = 0.907$).

4. Discussion

4.1 Behaviour and Speed

Work related stress of the donkeys expressed in behavioural responses were load dependent and grossly fell in two categories. The displayed behaviours were aggressiveness, defecation, ear erecting, tail wagging, smelling and moving backward for loads between 100 kg and 500 kg. When loads exceeded 500 kg, heavy and rapid panting, refuse moving forward and falling down were the most occurred behaviours. Behavioural responses are the first line of defense to environmental challenges, and stress responses in donkeys are always conducted on the basis of irregular behavioural phenomena. In donkeys, signs of fatigue include unwillingness to continue, uncoordinated legs and excitement after work, and continuous working causes them increased stress [7, 21].

The displayed behaviours are not common under ordinary environment and they occurred as the consequence of the applied loads. As the load increased to 600 kg and 700 kg, the animals refused to move, fell down and panted heavily and rapidly. Thus, this indicated that behaviours were affected by magnitude of the load. In particular, heavy loads that exceed 500 kg, the related behaviours had a serious impact on welfare of the animals.

Speed of the animals was in the range of 3.68 km/h (at 100 kg) and 2.54 km/h (at 700 kg), therefore the highest speed at the minimum load and the lowest speed at the maximum load. It is recommended 4 km/h speed and 6 h working time a day for a donkey weighing 200-300 kg and carrying 25-70 kg [22]. During ploughing experiment using a single donkey with heaviest, heavier and light ploughs, the corresponding speeds are 2.67, 2.84 and 2.98 km/h, respectively [23].

There are similar findings on animals' workload and displayed behaviour. Heart rate is generally regarded as a reliable indication of workload and correlates reasonably well with stepping rate, speed and power [24].

The speed of the animals started to decline successively from 500 kg to 700 kg loads, and this was a sign of fatigue, indicating that welfare of the animals was affected. If owners disregard this behaviour and continue working with the animal, more serious consequence could occur.

Stress responses in donkeys are always conducted on the basis of irregular behavioural phenomena that may be difficult to interpret [25, 26]. Under this condition, donkeys are subjected to different stressors, which may compromise their health and consequently result in poor performance [27]. Stress generally affects the host defense system and increases its susceptibility to infections [28]. The different conditions, by which donkeys are subjected to, are improper housing and handling that expose them to wounds and infection mostly during the hot-dry and rainy seasons [11]. Besides, donkeys need supplements, especially throughout the dry season, when they are increasingly used for traction [29].

4.2 Heart Rate

The measurement was conducted in April and temperature and relative humidity were 15-25 °C and about 60%, respectively. Heart rate of control animals was 46 ± 6 bpm at resting state. During mean daily meteorological data (31.20 ± 0.27 °C, 74.80% ± 1.44%), the mean heart rate of pack donkey was 52.67 ± 2.40 bpm [26]; it is higher heart rate than control animals and it may be due to temperature and relative humidity differences.

Donkey heart rate is stress quantifiable parameter used to define stress level under continuous work, and the standard range is H_0 + (15-45) bpm, where H_0 is the heart rate at rest [30]. According to the author under work condition, the growth of heart rate should be in the range of 15-45 bpm. During the experiment depending upon the load, rapid heart rate growth was recorded with the highest at 129 ± 11 bpm. In respect to resting state, the heart rate of working animals was elevated by a factor of up to 3. It is evident that work is stressful to donkeys that can not be avoided. However, the central question is to what extend should the animals be exposed to work stress without their welfare being compromised. In this regard, it is stated that the standard stress ranges are H_0 + (15-45) bpm [30]. But the recorded measurements were greater than what are recommended by the author, i.e., (46 ± 6) bpm + (81 ± 12) bpm to (46 ± 6) bpm + (129 ± 11) bpm. Despite short working hours (30-40 min), the heart rate exceeded the recommended ranges. Therefore, it clearly indicates that they were under stressful condition. The average heart rate of two donkeys at maximum exercise was 223 ± 2 bpm, representing a fivefold increase over the pre-exercise heart rate value [31].

During pulling carts of various loads, the displayed behaviours, working speed and heart rate of the donkeys jointly provided a picture on the stress level of the animals. It can be concluded that at loads between 500 kg and 700 kg, the speed sharply declined to from 3.5 km/h to 2.5 km/h. Besides, at these loads, they displayed behaviours, like refuse to move, heavy and rapid panting and falling down, and these illustrated very stressful condition. In the meantime in respect to resting state, the heart rate elevated from 2.4 times up to 3 times.

5. Conclusions

Alteration of walking speed of load pulling donkey was key behavioural indicator, as it is inversely correlated with load, and donkey owners or operators have to be observant to the speed and react accordingly to not compromise welfare of the working animal.

While pulling a load on two different wheeled cart, the relationships between load and donkey's welfare was influenced by a number of factors. As the load exceeded 400 kg, the speed declined significantly. The behavioural observation confirmed that animals were showing heavy panting and falling down. This leads to the conclusion that animals could pull about 2.7 times of their live weight.

However, if the animal is subjected to continuous and long working hours (about 6 h), it is recommended to keep the load about double of its live weight so as to safeguard the animal's welfare.

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