

INFLUENCE OF ROAD TRANSPORT STRESS ON CATTLE HEART RATE AND BEEF QUALITY: A REVIEW

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ABSTRACT

This paper discusses the influence of road transport stress on cattle heart rate and beef quality. The demand for beef and beef products has resulted in increased road transport of cattle which is the predominant means of cattle transport especially in developing parts of the world. Stress due to road transport exposes cattle to physical, psychological, and climatic factors that affect the animals with different intensities and duration. The most dominant stress factors associated with road transport of cattle include loading and unloading, bad handling, inappropriate driving, poor road conditions, too hot or too cold climate, insufficient ventilation, high stocking densities, mixing of unfamiliar groups, water and food deprivation, vibration, vehicle motion and length of the journey. These stress factors result in an increased heart rate which distort homeostatic balance of the animal, thus leading to induced changes in the secretion of pituitary hormones, altered metabolism, immune competence and behaviour which result in Dark Firm Dry (DFD) and Pale Soft Exudative (PSE) beef products which are unattractive and unpalatable to consumers. It is concluded that road transport is a source of stress for cattle. Road transport conditions are very essential factors which affect heart rate of the animal, this directly impacts the physiological wellbeing of the animal with direct influence on the quality of beef produced. Therefore it is recommended that all stake holders in the road transport sector should be trained on the techniques of handling cattle during transport. Specialized vehicles should be designed for road transport of cattle.

Keywords: Transport, Heart Rate, Stress, Road, Cattle, Beef, Cortisol

INTRODUCTION

Stress can be defined as a biological response elicited when an animal perceives threat to its homeostasis (Mob erg, 2000). There is increasing transport of livestock through long distances, as demand for meat products increases freight opportunities grow and trade barriers are reduced (Phillips, 2015). Most of this transport is by road. The physiological responses of animals to adverse conditions such as those which they may encounter during handling and transport will be affected by the anatomical and physiological constitution of the animal. Cattle transport produces physical, psychological, and climatic stressors that affect animals with different intensities and duration (Earley, 2010). There is no doubt that long transport is an unknown procedure for cattle which can be irritating and aversive (Hartung, 2003). This will lead to a persistent increase in heart rate of the animal which will cause an increased level of cortisol and other stress hormones that will affect beef quality. Warriss (2000) defined meat quality on the basis of their functional or conformational qualities. Functional qualities were referred to as the desirable attributes in a product while conformance qualities encompass producing a product that meets consumer's specification exactly. Yield and gross composition, palatability, wholesomeness and ethical quality are the components of meat quality (Warriss, 1996). Therefore this review elaborates the influence of road transport stress on cattle heart rate and beef quality.

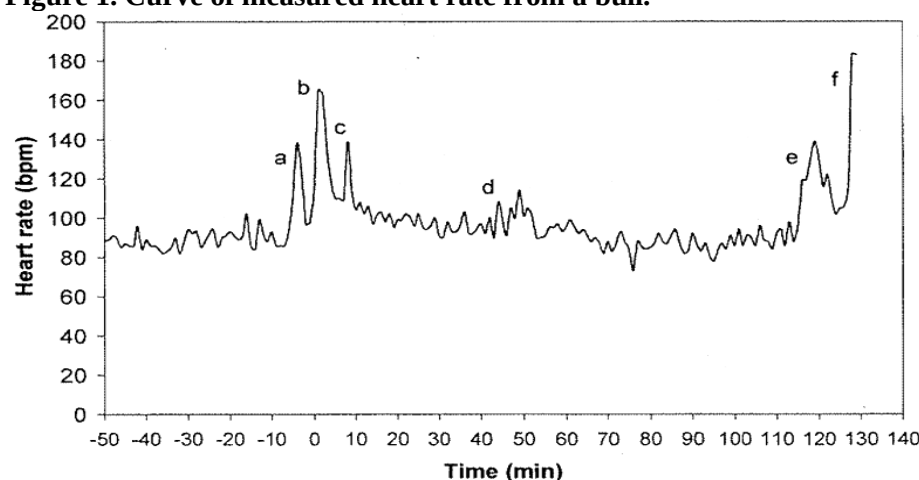
Factors Causing Transport Stress

The most pervasive factors with cattle transport include loading and unloading, bad handling, inappropriate driving, poor road conditions, too hot or too cold climate, insufficient ventilation, high stocking densities, mixing of unfamiliar groups, deck height, water and food deprivation, vibration, vehicle motion and length of the journey (Hartung, 2003). The duration of the journey has a greater impact than the distance (Von Borell, 2005). The main critical issues resulting in stress during transport are due to factors like inadequate road vehicles, illegal route plan and non-compliance with travelling speed limit, negligence and poor handling of animals, transport of unfit cattle, inadequate ventilation, over loading and difficulty in checking that vehicles were authorized to transport cattle (Singh, 2012). Some other stress inducing factors during transport are the attitudes of stakeholders and their driving skills, laws and codes of practice, genetic differences between breeds, design of vehicle for transport and design of equipments used for loading, payment of persons working with animals (Broom, 2003).

Table 1: Stressors in cattle transportation

Stress	Stressor	Effect
Behavioural	Novelty, restraint, noise	Fear
	Mixing, overcrowding	Aggressive interaction
Nutritional	Fasting	Dehydration and hunger
Physical	Mixing & overcrowding	Bruising and injury
	road conditions	Bruising and injury
	driving technique& horns	Bruising and injury
	Weather extremes	Hyper/hypothermia
Infectious	Dust exposure	Respiratory disease

(Ashenafi, 2018)

Influence of road transport stress on cattle heart rate**Figure 1. Curve of measured heart rate from a bull.**

(Gebresenbet, 2005)

- a) Animal near experimental animal is loaded
- b) Loading
- c) The vehicle starts to drive
- d) Loading of new animals
- e) Unloading at abattoir
- f) In the stunning box

X-axis represents time in minutes where 0 represent loading, negative time is before loading and positive after loading.

A typical heart rate curve is shown in figure 1. The first peak occurred when an animal near the experimental animal was loaded, the second peak at loading, the third peak when the vehicle started to drive, the fourth small peak occurred when new animal was loaded to the vehicle, and the fifth and sixth peak when the bull was unloaded and then forced to go into the stunning box (Gebresenbet, 2005).

Effects of increased heart rate on hormones

Increased heart rate as a result of transport stress triggers an increase in activity of thyroid and adrenal function in cattle which continues to increase after long distance transport (Fazio, 2005). Physiological changes encountered during road transport induced heart rate increase include plasma cortisol levels, breathing rate, extent of muscle tremor, foaming at the mouth, changes in adrenaline and noradrenaline (i.e., epinephrine and nor epinephrine), plasma or saliva glucocorticoid levels, saliva cortisol levels, increases/decreases in body temperature, physical signs of nausea or motion

sickness, plasma vasopressin levels, plasma β -endorphin levels, plasma Adrenocorticotrophic hormone (ACTH) levels, plasma creatinine levels, plasma lactate dehydrogenase levels (Ashenafi, 2018). Cortisol concentrations are used extensively as an indicator of stress because cortisol is released during the activation of the Hypothalamus, Pituitary and Adrenal glands (HPA) axis in response to stressful stimuli (Swanson, 2001). It has been widely documented that increased heart rate in response to transportation in the bull, cow and calf elicit an elevation in plasma cortisol levels which result in high levels of plasma urea and glucose (Guardia, 2009; Averos, 2008).

Effects of increased heart rate on beef quality

Elevated heart rate levels have a direct impact on cortisol. This influences other blood physiological parameters such as depletion of glycogen reserves which lead to a decrease in post-mortem lactic acid production (Colditz *et al.* 2006; Mounier *et al.* 2006). This lead to two major conditions namely Pale Soft Exudative (PSE) and Dark Firm Dry (DFD) beef. Pale soft exudative and dark firm dry beef are very important beef quality problems that continuous to bedevil the beef industry, PSE and DFD beef are unattractive and more likely to face discrimination by consumers (Viljoena *et al.*, 2002). Pale soft exudative beef looks pale, lean, has soft texture and low water holding capacity and poor functional attributes. Dark firm dry beef looks dark, variations in tenderness, poor functional attributes and prone to spoilage. Detailed description of pale soft exudative and dark firm dry beef can be found in Adzitey and Nurul (2010).

CONCLUSIONS

There is clear indication that road transport represent a source of stress for cattle. Transport conditions are very essential factors which affect heart rate of the animal. This directly impacts the physiological wellbeing of the animal which has direct influence on the quality of beef produced.

Transport stress → Elevated heart rate → physiological changes → PSE & DFD Beef

RECOMMENDATIONS

All stake holders in the road transport sector should be trained on the techniques of handling cattle during transport. Specialized vehicles should be designed for road transport of cattle. Private investors should be encouraged to invest in modular abattoirs so as to reduce distance and duration of road transport for cattle.

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