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The Effect of long Distance Transportation Stress on Cattle: a Review

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Abstract

The aim of this article is to review scholarly work carried out on the effect of long transportation stress. Stress due to long transportation of cattle can be measured by comparing baseline measurements when the animal is not subjected to a stress inducing factors, to those measured when an animal is experiencing a stressful event. Cattle transport produces physical, psychological, and climatic factors that affect animals with different intensities and duration. The most pervasive factors of long transportation of cattle include, pre-transport management, the attitudes of stakeholders and inappropriate driving skills, laws and codes of practice, methods used during handling, loading and unloading, the design of vehicle and equipment used for loading, and poor road conditions. Other important factors causing stress are insufficient ventilation, high stocking densities, mixing of unfamiliar groups and social regrouping, feed and water deprivation, noise, vibration, novelty, time of transit and length of the journey, genetic differences between breeds, and payment of persons working with animals, actual physical climatic condition and risk of disease transmission.

The effect of stress during long transport is assessed using a range of behavioral, physiological and carcass quality measures. Stress may result in induced changes in the secretion of pituitary hormones, thus leading to altered metabolism, immune competence and behavior, as well as failures in reproduction. Thus, stressful conditions can reduce the fitness of an animal, which can be expressed through failure to achieve reproductive and production performance standards, or through morbidity and mortality. This review article argues that, to mitigate the negative effect of long transport stress on cattle physiology, remedial strategies such as administration of vitamins, vaccines, feeding high-energy diets, and electrolyte therapy should be considered.

Keywords: Stress; Cattle; Transport 3.

Abbreviations: ACTH: Adereno-Contico Tropic Hormone; BRD: Bovine Respiratory Disease; FFA: Free Fatty Acids; HPA: Hypothalamic-Pituitary-Adrenal

Introduction

Stress can be defined as a biological response elicited when an animal perceives a threat to its homeostasis [1]. Also define stress as adverse effects in the environment or management system which forces changes in the animal's physiologic or behavior to avoid physiological malfunctioning and assist the animal in coping with its environment [2]. Animals can be stressed by either psychological stress; restraint, handling or novelty or physical stress: hunger, thirst, fatigue, injury or thermal extremes [3]. Stress is a major aspect of animal welfare and can be assessed using many quantitative physiological variables and the most obvious indicators that an animal is having difficulty coping with handling and transport are changes in behavior [4]. 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 [5]. There is no doubt that long transport is an unknown procedure for cattle which can be irritating and aversive [6].

Factors Causing Transportation Stress

The most pervasive factors with long transportation 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, deck height, water and food deprivation, vibration, vehicle motion and length of the journey [6]. The duration of the journey has a greater impact than the distance and after long transport; most animals drink and then lie down [7]. In addition, pre-transport management, noise, vibration, novelty, social regrouping, crowding, climatic factors (temperature, humidity and gases), restraint, and time of transit [8]. The main critical issues resulting in stress during long transportation is due to factors like inadequate road vehicles, illegal route plan and non-compliance with travelling time limit, negligence and poor handling of animals, transport of unfit cattle, insufficient facility, ventilation, inroad vehicles.

Over-loading, difficulty in checking that vehicles were authorized to transport cattle and problems of norm interpretation [9]. Some other stress inducing factors during handling and transport are: the attitudes of stakeholders and their driving skills; laws and codes of practice; genetic differences between breeds, and different selection pressure; the design of vehicle for transport and design of equipment used for loading; payment of persons working with animals; the actual physical condition such as temperature, humidity and risk of disease transmission; the methods used during handling, loading and unloading methods [10] (Table 1).

Table 1: Stressors in cattle transportation.

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

Indicators and Physiological Measures of Long Transportation Stress

When we measure stress in an animal we really measure the changes the stressor causes in the animal (example, a rise in body temperature, when the animal is having a net gain of heat from its environment) or the responses it invokes in trying to re-establish a normal internal state (a rise in breathing rate when it needs to increase heat-loss-rate) [11]. Stress due to long transportation of cattle can be measured by comparing baseline measurements when the animal is not subjected to a stress inducing factors, to those measured when the animal is experiencing a stressful event [12]. Moreover, levels of stress can be measured by physiological parameters such as heart rate, body temperature, respiration rate and hormonal changes [10,13]. Physiological responses such as heart rate and blood hormones are good indicators to study animal stress effects [14]. Additionally, transport stress triggers an increase in activity of thyroid and adrenal function in cattle that continues to increase after long-distance transport [15].

Physiological measurements of stress are dependent on the interaction of many systems. Some stress responses can be measured by the functionality of the primary system involved [7]. Physiological measures indicate that long transport of cattle can result in immune suppression, which can lead to increased susceptibility to disease and might result in increased pathogen shedding [16]. Physiological measures encounter during long transport include: plasma cortisol levels, heart rate, 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 cortical levels, increases/decreases in body temperature, physical signs of nausea or motion sickness, plasma vasopressin levels, plasma ß-endorphin levels, plasma Adereno-Contico Tropic Hormone (ACTH) levels, plasma creatine kinase levels, plasma lactate dehydrogenate levels.

Osmolality of the blood, plasma ß-hydroxybutyrate levels, behavior when allowed to eat or drink, white blood cell counts, red blood cell counts, activity and efficiency of lymphocytes and immunosuppressant [10]. Cortical concentrations are used extensively as an indicator of stress because cortisol is released during the activation of the HPA axis in response to stressful stimuli [17]. An elevation in plasma cortisol levels and catecholamine's in response to long transportation has been widely documented in the calf [18]. Transportation stress is known to cause an increase in plasma urea, which indicates an increase in protein and nucleic acids breakdown in the muscles, due to increase in cortical concentration and prolong food deprivation during stressful transportation conditions [19]. Creative kinas increase proportionately with the duration of the journey and remain high for several days after transport [20], because this enzyme is released into the blood stream when there is muscle damage and during vigorous exercise; high levels of this enzyme in the blood plasma indicate physical fatigue.

Additionally, transport stress triggers an increase in activity of thyroid and adrenal function in cattle that is evident after even short journeys and continues to increase after long-distance transport [15]. Plasma glucose is one of the commonly used physiological indicators of stress during transportation [21]. Transportation stress has been reported to cause an elevation in plasma glucose concentrations due to an attempt to make up for energy loss during transport, glucose is mobilized from glycogen in the liver and muscles into the systemic circulation or due to depletion of glycogen reserves from the skeletal muscles [22]. Increase in plasma glucose concentration is mainly due to glycogenolysis associated with the increase in catecholamine's and glucocorticoids which were released during the stress of long transportation [23]. The concentration of plasma total protein, albumin and hemoglobin were observed to increase when animals suffer from dehydration as a result of long hour transport [24], but the increase was independent of the journey time [19].

Changes in mineral metabolism during cattle transportation involve mainly calcium, magnesium, sodium, potassium and chloride [22]. An increase in muscles activities of stressed cattle results from a rise in calcium ion concentration in the extracellular tissue fluid. The concentration of magnesium in body tissue decreases during transportation, which led to a change in the activity of mitochondrial membrane of cells. The energy exchange of skeletal and heart muscle is seriously affected by lack of magnesium. Stress together with lack of magnesium causes an increase in the synthesis and release of catecholamine, resulting in an increase in cell permeability [25]. One indicator of the impact of stress on the immune system is characterized by the ratio of neutrophils to lymphocytes, which are types of white blood cells. Heart rates can be recorded by telemetric system to monitor the stress response of the cardiovascular system [11].

Effects and Implications of Long Distance Transportation Stress

Stress resulted in induced changes in the secretion of pituitary hormones, thus leading to altered metabolism, immune competence and behavior, as well as failures in reproduction [7]. Stress reduces fertility by disrupting the intricate and precisely regulated hormonal cascade that controls the gonadal development and functions [26]. As a consequence, stress retards development of ovarian follicles, reduces ovulation, increase embryo and fetal loss, extends the interval from calving to conception and increases the services required per conception [27]. Thus, stressful conditions could diminish reproductive success and is responsible for sub-fertility [11] (Table 2).

Table 2: Commonly used physiological indicators during long transport.

Stressor	Physiological variable measured in blood or other body fluid
Food deprivation	Increased FFA, B-OHB, glucose, urea
Dehydrations	Increased osmolality, total protein, albumin, PCV
Physical exertion	Increased CK, lactate
Fear, lack of control	Increased cortical, PCV
Motion sickness	Increases Vasopressin
Fear, physical effects	Increased heart rate, respiration rate
Hypothermia/hyperthermia	Body temperature, skin temperature

Animals feel stress too, and it can compromise their health and ability to thrive, that, in turn, can cost producers money [7]. Animals raised in less than ideal conditions may have reduced weight gain, milk production, birth weights and survival while making stock management more difficult [27]. Stress can have detrimental effects on the quality of food products which can pose serious economic issues for the livestock industry due to increased costs ultimately borne by the producer and the consumer. Stress reduces the fitness of an animal, which can be expressed through failure to achieve production performance standards, or through disease and death [11].

Calves

Young calves are particularly poorly adapted to cope with transport, because their immune system and stress response are not yet fully developed. Thus, young calves are especially vulnerable to long transport stress resulting in high morbidity (from diarrhea, pneumonia and shipping fever) and mortality rates of between 1% and 23% [28]. Immunosuppressant after transportation predisposes calves to developing bovine respiratory disease (BRD), which commonly occurs in the first 45 days of arrival and is associated with 65 to 80 % morbidity and 35 - 55 % mortality. Therefore, even a modest reduction in stress after transportation could have a significant economic benefit for cattle producers [29]. Young calves respond to transport with an increase in body temperature, heart rate and plasma cortisol concentration (indicative of stress) [30] and significantly increased levels of adrenaline [31]. Recent findings showed transported calves had increased rectal temperature and increased risk of respiratory disease following long transportation. The transported calves showed signs of energy mobilization (increased plasma concentration of free fatty acids (FFA) and physical exertion (increased plasma activity of creatine kinase), but were not dehydrated [32]. Also activation of the hypothalamic-pituitary-adrenal (HPA) axis was found after calf transport [33].

Dairy and Beef Cattle

Mortality of adult cattle during road transportation increases with the length of the journey: a six fold increase in mortality of fattened cattle and 15-fold increase for dairy cattle for long journeys of more than 300km when compared with short journeys of less than 50km [34].

Remedial Approaches

The European Union (EU) legislation on animal including cattle welfare during transport has been widely modified in the last three decades to improve the protection of animals during long transport [20]. The following breaches of the legislation have been common for many years: deficient checks of journey logs; failure to give animals the rest, food and water; exceeding the permitted loading density; insufficient headroom; failure to provide water on the vehicle; the use of vehicles that fail to meet the legislative standards for journeys exceeding eight hours; the transport of unfit animals, and lack of certification for the drivers [34]. Recovery from long distance transport to pre-transport levels is slow because of the disruption of eating cycles and water deprivation. Recovery can take as long as 5 day after transport [35].

This review article argues that various remedial strategies have been attempted to decrease cattle response to transportation stress such as preconditioning, administration of vitamins, vaccines, feeding high-energy diets, and electrolyte therapy. The use of long-acting non-steroidal anti-inflammatory drugs (NSAIDs), specifically meloxicam is suggested having practical benefits, to mitigate the negative effect of long transport on cattle physiology [29]. These approaches to managing long transport stress have met with little success. During long duration transport, it is important to ensure

that floor conditions and stocking density allow proper rest to take place [36]. Quality of driving and various aspects of vehicle design, such as shock absorption, are factors, which influence the comfort of the transported cattle [37,38]. For adult cattle recommended a rest period of at least 6 hours after 12 hours of travel, during which food and water should be provided [20].

Conclusion and Recommendation

Most studies indicate long transportation represents a source of stress for cattle. The effect of stress effect of long transportation can be measured using physiological as well as behavioral parameters. In the case of long-distance transport, recovery to pre-transport levels is slow and it can take as long as 5 day after transportation because of the disruption of eating cycles and water deprivation. However, there are some limitations regarding the measurement of the parameters and this includes, the decrease or increase in any physiological measurements may induce not only by stress of transportation but also due to other environmental factors. Therefore, these physiological indicators should be taken as an opportunity but not considered as the main once.

After reviewing different scholarly work carried out on the effect of long transportation stress we forward the following recommendations for future line of works:

a. Physiological parameters were doubtable for measuring the effect of stress in cattle since other factors also may lead to change of these physiological indicators, therefore, appropriate measuring techniques should be devised to measure the indicators specifically.

b. Cattle transport should be avoided during extreme weather conditions and should be limited to short journeys and cattle must be handled in a safe and suitable way to ensure they are free from hazards and stresses.

c. During transportation and handling of cattle, implementing international standard guidelines and strategies as well as utilization of recommended special vehicles and recruitment of well trained professionals at different levels to decrease the negative effects of stress.

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