Evaluation of multi decked transported sheep in a hot and humid tropical environment

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Abstract. Unavoidable transportation as a supporting factor in meat production is a common cause of stress that may affect economic loss and welfare concerns. This study was evaluated sheep's economic losses and physiological responses with two and three-level deck numbers. This study was used 127 heads of local Indonesian sheep, 8-10 months in age with 18-24 kg live body weight. A total of 72 heads of sheep were used for three deck levels (study 1) and 52 heads of two deck levels (study 2). All the sheep were loaded on the pick up at a 0.14 m²/head of density and transported for 22 hours without fed and water access during the journey. During the study, ambient temperature and relative humidity fluctuated between 29 and 34°C and 74 and 93%, indicating that the season was thermally stressful and unfavorable for sheep transport. The results showed that transported sheep using an open pick up for 20 hours in Indonesian conditions significantly affected physiological and blood parameters as indicator stress and inventory loss caused economic losses. It can be concluded that transported sheep into two or three levels of the deck in tropical climate had a high risk for sheep in terms of economic and animal welfare concerns.

1. Introduction

Nowadays, the optimization of ensuring animal welfare during transport for livestock animals has become a strong interest in many researchers worldwide [1]. Loading and unloading, stocking density, environmental temperature and humidity, road type, prolonged standing, unfamiliar mixing, hunger, thirst, and driver behavior are several stressors that influenced animal wellbeing during transport [2, 3, 4, 5, 6]. Stressed transport could significantly impact animal performance, increase mortality, and decrease meat quality [7], particularly in hot climates [9]. The sheep were put in a lying down position with high loading density without access to feed and water for more than 20 hours of road transport. As a result, there is no regulation and procedure of standard for transport animals in Indonesia.

Characteristics of the vehicle and the way are driven by two critical factors that influenced animal welfare during transport [8]. In Indonesia, sheep are frequently transported for long distances by multi-decked open-sided pick-up, relying on free ventilation due to vehicle movement. Moreover, poor ventilation may lead to heat stress, particularly in hot climates [9]. The sheep were put in a lying down position with high loading density without access to feed and water for more than 20 hours of road transport. As a result, there is no regulation and procedure of standard for transport animals in Indonesia.

Numerous study has examined the physiological responses of transported sheep in temperate and hot dry climates. However, there is very little information about road transported sheep in hot and humid
climates on physiological stress, particularly in the Indonesian condition. Applied this research can help to provide detailed scientific data to establish national regulation regarding animal welfare concerns and decreasing economic losses for long-distance transport. This study evaluated economic losses at habituated multi-deck sheep transported under the Indonesian condition and how that affected physiological and blood-stressed indicators.

2. Material and methods

2.1. Animal and management
A total of 228 healthy local Indonesian sheep 8-10 months of age with 18-24 kg live body weight was used in this study. Before the study, the animals were clinically examined, and healthy sheep were purchased. The completed fattening ration was fed to sheep twice a day, and water was supplied ad libitum.

2.2. Experimental design and treatment
This experiment was carried out in September-November 2019. We followed four times of habituated transport of supplied sheep in a commercial farm in Bogor, Indonesia. This journey was performed from Magetan to Bogor with two and three levels of the deck (two replicates in each) with a difference of two weeks between each journey. All the 228 sheep in four times the journey was used to evaluate economic losses, while physiological and the blood sample was taken from 10 sheep in each journey. Magetan and Bogor have temperatures from 26°C to 32°C and relative humidity 70 to 93%.

2.3. Transport vehicle, loading, and journey time
An open pick-up was used for the journey with a space allowance of 0.13-0.15 m² per head. The floor of the vehicle, measured 2.20 m (L) x 1.48 m (W) x 1.2 m (H) was covered with wood shavings without any bedding. The compartment of the vehicle was divided into two or three compartments using wooden panels. Live weight, physiological measurement (rectal temperature, respiration rate, and heart rate), and blood sample were measured 1 hour before loading every journey. All sheep were loaded into vehicles and transport for about 18-20 hours to sheep farming in Bogor with a total traveled distance was 684 km, mostly on national highways with heavy traffic and traffic light. The ambient temperature during loading for every journey was relatively similar was 30-32 °C. There was no access to feed and water throughout the journey.

2.4. Blood sample and physiological measurement
Blood samples and physiological (rectal temperature, respiration rate, and heart rate) were taken from 10 sheep in each journey before and immediately after transport. A total of 5 ml were collected from the jugular vein of sheep and put into two sterile tubes, one tube containing 0.14% anticoagulant (EDTA K3, Onemed Healthy Care, Australia) to determine hematological (red blood cell, hematocrit, white blood cell, neutrophil, lymphocyte, monocyte, and neutrophil: lymphocyte ratio) by using an automatic blood analyzer Abaxis Vetscan HM5 (American). The second tube without anticoagulants to get the serum. Blood serum was obtained by centrifugation at 3,000 rpm for 10 minutes and stored at -20 °C for analysis of blood metabolites. Serum cortisol hormone was measured by competitive ELISA method (Cat: EIA 1887 DRG, Instrument GmbH, Germany). Analyses for glucose and creatinine kinase were used an automatic spectrometer (Switzerland). After following blood sampling, individual rectal temperature was recorded using a digital thermometer Digital Omron thermometer, Model MC-246, Japan), respiration rate was measured with the help of flank movement, and pulse rate was recorded from the coccygeal artery with the help of a stethoscope. In contrast, body weight was measured by weighing the sheep using a digital hanging scale.
2.5. Economic losses
Economic loss measurement in this study was determined by counting all the inventory loss during transport (body weight losses, number of death, and exhausted sheep) for every two and three deck levels in the transport period.

2.6. Statistical analysis
ANOVA analyzed the differences between treatments and following a t-test for physiological and blood parameters data. At the same time, economic losses were measured by descriptive analysis with the help of SPSS software version 25.

3. Result and discussion
After 20 hours of transportation, body weight, physiological, and blood parameters values were changed, consequently impacting economic losses. Live body weight loss in two groups was 11.41% and 11.61% (Table 1). Inventory losses due to 20-h transport without access fed and water consists of body weight loss, death, exhausted or injury. Three deck compartments showed more significant total loss than two decks. It may cause two decks compartment had a lower transport cost.

Table 1. Journey description, transport risk, and economic loss for transported sheep.

| Journey descriptive | Number of deck |
|---------------------|----------------|
|                     | 2              | 3              |
| Length of transport (km) | 684           | 675           |
| Duration (hour)      | 22             | 22             |
| Number of sheep for transport (head) | 52           | 72             |
| Loading density (m²/head) | 0.14         | 0.14          |
| Transport risk of sheep |               |                |
| Number of death      | -              | 1              |
| Number of exhausted  | 1              | 3              |
| Number of injury     | -              | 1              |
| Inventory loss       |                |                |
| Body weight before transport (kg) | 21.74       | 21.54         |
| Body weight after transport (kg) | 19.26       | 19.04         |
| Body weight loss (kg/head) | 2.48         | 2.50          |
| Body weight loss (%) | 11.41         | 11.61         |
| Total body weight loss (kg) | 128.96      | 180.00        |
| Total body weight loss (IDR) | 6448000    | 9000000       |
| Death loss (IDR)     | -              | 1077000       |
| Transported cost (IDR) | 4000000    | 4000000       |
| Total economic loss (IDR) | 10448000  | 14077000      |
| Transported cost (Rp/kg body weight) | 3538.32    | 2579.18       |
| Body weight loss per kg body weight (IDR) | 5703.77    | 5803.16       |
| Total economic loss per kg BW (IDR) | 9.242.09  | 8.382.34      |

Rectal temperature, respiration rate, and pulse rate are essential to physiological and an ideal indicator for assessing stress in animals [10]. Rectal temperature, respiration rate, and pulse rate were increased significantly (P<0.05) as a result of 20-h transportation in Indonesian condition both of two and threedock compartment group but, the differences between two groups were not significant (Table 2). Increasing rectal temperature, respiration rate, and pulse rate relate to heat stress during transport.
Table 2. Thermal physiological responses of sheep before and after transport.

| Items                        | Before transport | After transport | 2 number of deck | 3 number of deck |
|------------------------------|------------------|-----------------|------------------|------------------|
| Rectal temperature (°C)      | 39.00±0.29       | 39.48±0.20      | 39.60±0.33       |
| Respiration rate (beat/min)  | 44.67±3.21       | 74.00±4.12      | 78.67±4.11       |
| Pulse rate (beat/min)        | 92.80±4.92       | 130.00±6.20     | 132.00±6.40      |

In the present study, transported sheep using an open pick up for 20-h led to increased cortisol, glucose, creatinin kinase, red blood cell, white blood cell, neutrophil, and N/L ratio than before transportation. Both groups decrease lymphocyte number (Table 3). The number of the deck on compartment significantly impacted of cortisol, glucose, creatinin kinase, red blood cell, and neutrophil: lymphocyte ratio (P<0.05). Cortisol, glucose, creatinin kinase, red blood cell, and N/L ratio were higher in three deck compartments than two deck compartments.

Table 3. Physiological welfare indicator of sheep before and after transport.

| Items                        | Before transport | After transport | 2 number of deck | 3 number of deck |
|------------------------------|------------------|-----------------|------------------|------------------|
| Hormone cortisol (ng/mg)     | 16.42±4.42       | 53.39±4.20      | 68.84±5.30       |
| Glucose (mg/dl)              | 49.62±3.90       | 68.90±4.24      | 77.48±5.34       |
| Creatinin kinase (U/L)       | 184±8.56         | 245±10.24       | 286±9.50         |
| Red blood cell (10^6/µl)     | 9.08±0.41        | 10.55±0.25      | 11.62±0.42       |
| Hematocrit (%)               | 28.39±0.98       | 30.29±1.80      | 31.23±1.24       |
| White blood cell (10^3/µl)   | 9.82±0.34        | 11.19±0.63      | 11.43±0.45       |
| Neutrophil (10^3/µl)         | 3.53±0.42        | 6.04±0.65       | 6.86±0.48        |
| Lymphocyte (10^3/µl)         | 6.32±0.46        | 5.08±0.62       | 4.50±0.82        |
| Monocyte (10^3/µl)           | 0.06±0.01        | 0.07±0.01       | 0.07±0.01        |
| Neutrophil:Lymphocyte        | 0.57±0.12        | 1.19±0.14       | 1.52±0.16        |

In our results, N/L was significantly higher after transporting two and three decked of the compartment, probably associated with the stress-induced cortisol release that may cause neutrophilia and lymphopenia [18]. These findings suggest that prolonged exposure to transport in a lying-down position with high stocking density under Indonesian conditions can increase the probability of health problems and affect the sheep’s ability to cope with transport. In the event, the number of red blood cells, white blood cells, and hematocrit were within the average standard reference value for sheep [19].

Overall, the sheep in the three decks of the compartment had a higher level of cortisol, glucose, creatinin kinase, red blood cell, and N/L ratio suggested that they underwent more stress than two deck compartment sheep. Open pick-ups were designed to optimize space and stocking rates, but there is a
cost for sheep’s welfare and comfort during long distances. Moreover, Minka and Ayo [20] stated that using vehicles with poor design or doors that are too narrow and designed early to transport goods should be avoided.

4. Conclusion
These results indicated that transported sheep using an open pick up for 20 hours in Indonesian conditions significantly affected physiological and blood parameters as indicator stress and inventory loss that caused economic losses. A new design base on the results of further scientific studies should help alleviate those problems.

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