Short Communication

The Effects of Organic Chromium Supplementation on Physiological Responses and Body Weight Loss in Jawarandu Goats Under Transportation Stress

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Abstract | Transportation in goats often induces stress, which may lead to body weight loss and alterations in physiological responses. One potential strategy to mitigate transportation-induced stress is supplementation with organic compounds that can enhance insulin sensitivity, reduce cortisol levels, and improve energy metabolism. The present study aimed to evaluate the effects of organic chromium (Cr^+) supplementation on physiological responses (pulse rate, respiratory rate, and rectal temperature) and body weight loss in goats after transportation. The experimental animals were male Jawarandu goats subjected to three treatments: no Cr^+ supplementation (control) (P0), 0.5 ppm Cr^+ supplementation (P1), and 1 ppm Cr^+ supplementation (P2). Goats were transported over a distance of 289 km for approximately 5 hours by land transportation using an open-bed truck and an average vehicle speed of 60–80 km/h. During the transportation process, the animals were not provided with feed or drinking water with the starting point in Tegineneng District, Pesawaran Regency, Lampung Province, and the destination in Sukarami District, Palembang City, South Sumatra Province. Results of the repeated-measures GLM analysis revealed no significant differences among treatments ($p > 0.05$) in physiological parameters including pulse rate, respiratory rate, rectal temperature, and body weight change. These findings indicate that transportation induced noticeable stress, as evidenced by body weight loss, while supplementation with organic chromium had no effect on its alleviation. In conclusion, supplementation with organic chromium (Cr^+) at 0.5 and 1 ppm did not significantly affect physiological responses rectal temperature, pulse rate, and respiratory rate nor did it reduce body weight loss in Jawarandu goats.

Keywords | Body weight loss, Jawarandu goats, Organic chromium, Physiological responses, Stress, Transportation

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INTRODUCTION

One of the primary sectors contributing to the fulfillment of animal protein needs in Indonesia is the livestock sub-sector, in which goats play a significant role. In 2024, the goat population in Lampung Province reached 1,966,835 heads (BPS-Statistics Indonesia Lampung Province , 2025). Among the various goat breeds raised in the region, the Jawarandu goat is one of the most widely farmed (Widiastuti *et al.*, 2022). Jawarandu goats, also known as Bligon goats, are a crossbreed between male Kacang goats and female Etawah Grade goats (Widiastuti *et al.*, 2022). This breed possesses advantageous characteristics, including high adaptability to tropical environments and good productivity (Warman *et al.*, 2021).

In livestock production and distribution systems designed to supply animal protein across regions, transportation is an unavoidable stage that can induce physiological stress in animals. This process often results in metabolic alterations, performance decline, and body weight loss, particularly in goats (Bin Jumah *et al.*, 2020).

Transportation stress may trigger disruptions in physiological responses such as increased heart rate, respiratory rate, and rectal temperature. Additionally, transportation stress can increase body weight loss due to disruptions in homeostasis and changes in energy metabolism (Santosa *et al.*, 2012; Anwar, 2021). Besides negatively affecting animal welfare, transportation-induced stress also reduces production performance, making it a critical concern within livestock supply chains (Usto, 2017; Miranda de-la Lama, 2019).

Several factors contribute to stress during transportation, including rough handling during loading and unloading, mixing with unfamiliar animals, deprivation of feed and water, vehicle design, poor road conditions, stocking density, limited air circulation, extreme temperature and humidity, and wind speed (Santosa *et al.*, 2012).

To mitigate transportation stress, various studies have applied both organic and inorganic compounds. One substance recognized for its stress-reducing effects is organic chromium (Cr^+). Chromium is an essential mineral that enhances insulin sensitivity, optimizes energy metabolism, and reduces oxidative stress (Dubey *et al*, 2020; He *et al.*, 2023). In its organic form, chromium exhibits higher bioavailability than its inorganic counterpart, making it more effective in supporting physiological responses in livestock (Almeida *et al.*, 2024). Several studies have reported that chromium supplementation can improve production performance, maintain hematological status, and reduce stress in farm animals (Sahin *et al.*, 2003; Malik *et al.*, 2024). The mineral also plays a role in improving insulin sensitivity (Dillasamola *et al.*, 2014), lowering cortisol levels (Hamidi *et al.*, 2017), and enhancing energy metabolism in livestock (Zhang *et al.*, 2023).

Previous research has further shown that Cr^+ supplementation can enhance physiological responses and improve metabolic efficiency in ruminants under stressful conditions (Santosa *et al.*, 2012). However, no study has specifically investigated the effects of Cr^+ supplementation on physiological responses and body weight loss in Jawarandu goats subjected to transportation stress. Therefore, this study was conducted to evaluate the extent to which organic chromium can influence physiological responses and minimize body weight loss in Jawarandu goats during transportation. The results are expected to contribute to the development of mineral-based nutritional strategies to enhance the resilience of local goats against stress, supporting productivity and animal welfare in Indonesia.

MATERIALS AND METHODS

Time and location

The study was conducted over a period of two months, from June to July 2025. The experimental goats were maintained in a farmer's housing facility located in Margo Mulyo Village, Tegineneng District, Pesawaran Regency, Lampung Province. The transportation treatment was carried out using an open-bed truck and an average vehicle speed of 60–80 km/h. During the transportation process, the animals were not provided with feed or drinking water along the route from Tegineneng District, Pesawaran Regency, Lampung Province (departure point) to Sukarami District, Palembang City, South Sumatra Province (arrival point). Measurements of physiological responses and body weight were recorded both prior to departure and upon arrival at the destination.

Material used

The experimental animals consisted of adult male Jawarandu goats aged 1–2 years. The material used as a dietary supplement was organic chromium (Cr^+) in powder form packed in capsules under the Swanson® brand, manufactured in the United States. The organic chromium was thoroughly homogenized with rice bran grade A and administered prior to the daily feeding of forage and concentrate. The equipment used in this study included a DLE hanging scale with a capacity of 100 kg, a digital rectal thermometer, a stethoscope, a pickup truck for transportation, stationery (notebook and pen), and a camera for documentation.

Experimental design

This experiment employed a Completely Randomized Design (CRD) consisting of three treatments with three replications each, as follows:

- T0: Control (without organic chromium supplementation)
- T1: 0.5 ppm organic chromium (Cr^+)
- T2: 1 ppm organic chromium (Cr^+)

To ensure that the organic chromium was homogenously mixed and fully consumed by the experimental goats, it was incorporated evenly into rice bran grade A and offered before forage and concentrate feeding. The chromium-supplemented rice bran was provided in the morning

(07:00–08:00 Western Indonesian Time) and consumption was monitored to ensure complete intake before the main feed was supplied.

Transportation procedure

The goats were transported in the morning using an open-back pickup truck from Tegineneng District, Pesawaran Regency, Lampung Province to Sukarami District, Palembang City, South Sumatra Province (Figure 1). The journey lasted approximately 5 hours, covering a distance of 289 km at an average speed of 60–80 km/hour. During transportation, the goats were not provided with water or feed.

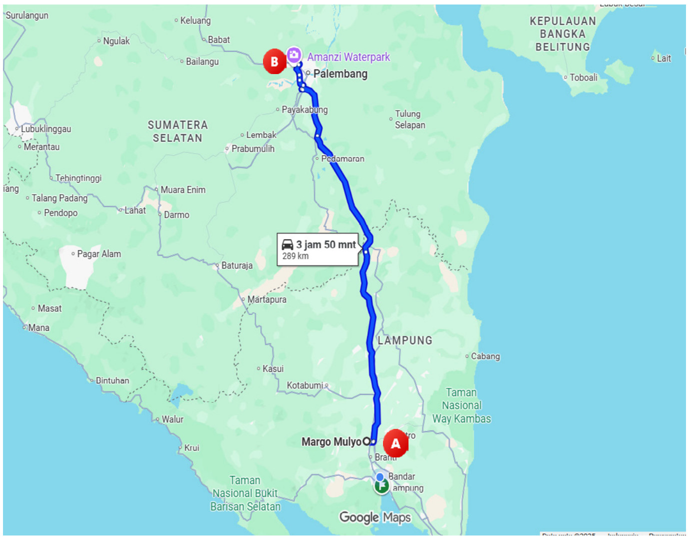

Figure 1: Transportation route from the departure point (A) to the destination point (B). (Screenshot from Google Maps).

Observed parameters

The parameters observed in this study included:

Body weight loss

Body weight was measured using a DLE hanging scale with a capacity of 100 kg. Weighing was conducted twice: one day before transportation and immediately after transportation. Body weight loss was calculated as the difference between pre- and post-transport body weight and expressed as delta (Δ).

Pulse rate (heart rate)

Pulse rate was determined by placing a stethoscope on the chest area (at the lower jaw angle directly above the carotid artery) for one minute while counting the number of heartbeats.

Respiratory rate

Respiratory rate was measured by counting the number of flank movements (inspiration and expiration cycles) per minute.

Rectal temperature

Rectal temperature was measured using a digital thermometer inserted approximately one-third into the rectum until the device beeped. The thermometer was then removed and the recorded temperature value was immediately read.

Data analysis

Statistical analysis was performed using the General Linear Model (GLM) Repeated Measures procedure at a significance level of 5% (0.05) with IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA). This approach was used to determine whether significant differences existed among treatment groups. If significant results were detected ($p < 0.05$), post hoc comparisons were conducted using the Least Significant Difference (LSD) test to identify specific differences between treatments.

RESULTS AND DISCUSSION

Table 1 presents the statistical analysis results for changes in body weight, pulse rate, respiratory rate, and rectal temperature before and after transportation across the three treatment groups (P0, P1, and P2). In general, all four parameters showed changes following transportation; however, organic chromium supplementation did not exert a significant effect ($p > 0.05$).

Table 1: Changes in body weight and physiological responses of Jawarandu goats supplemented with organic chromium before and after transportation.

Variables	Treatments (Average±Standard Deviation)		
	T0	**T1**	**T2**
Body weight (kg)			
Before transportation	30.87±8.36	32.20±8.36	29.47±8.36
After transportation	28.30±7.70	30.18±7.70	27.39±7.70
Change (Δ) ^{ns}	-2.57	-2.02	-2.08
Pulse rate (beats/min)			
Before transportation	92.33±19.40	88.33±16.01	89.33±24.09
After transportation	93.00±18.68	102.00±23.43	96.67±22.19
Change (Δ) ^{ns}	+0.67	+13.67	+17.33
Respiratory rate (breaths/min)			
Before transportation	49.00±10.44	57.67±14.29	47.67±5.51
After transportation	65.00±7.81	68.67±9.07	47.33±5.51
Change (Δ) ^{ns}	+16.00	+11.00	-0.34
Rectal temperature (°C)			
Before transportation	39.20±0.52	39.27±0.51	39.50±0.26
After transportation	39.57±0.42	39.43±0.15	39.47±0.31
Change (Δ) ^{ns}	+0.37	+0.17	-0.03

ns: non-significant (P > 0.05).

Body weight

The average body weights before transportation were P0= 32.50 kg, P1= 30.55 kg, and P2 = 29.49 kg; after transportation, they decreased to P0= 29.93 kg, P1= 28.53 kg, and P2= 27.41 kg, respectively (Table 1). These results indicate a significant reduction in body weight following transportation. However, supplementation of organic chromium at 0.5 and 1 ppm did not significantly influence the degree of weight loss ($p > 0.05$).

This substantial decline in body weight confirms the impact of transportation stress on body mass loss. These findings align with Li *et al.* (2024), who reported that transportation causes body fluid loss due to dehydration and elevated energy metabolism. According to Raghazli *et al.* (2021), weight loss in small ruminants after transportation may also result from restricted feed and water intake during travel. This condition triggers body shrinkage, typically ranging from 2–8%, depending on transport duration and conditions. In this study, goats transported for approximately 5 hours experienced a weight loss of 2–3 kg, which is similar to the results of Martinez *et al.* (2020), who reported significant body weight reduction in kids transported for only 2 hours without access to drinking water.

The lack of significant differences among treatments indicates that goats in P0, P1, and P2 were similarly affected by transportation. This is consistent with the findings of Kumar *et al.* (2024), who noted that factors such as travel duration, temperature, and stocking density play a more dominant role in weight fluctuations than dietary supplementation when management conditions are comparable.

Body weight loss following transportation has both economic and welfare implications. It reduces live weight selling value and indicates the need for a rest and recovery period before sale or slaughter. Therefore, implementing low-stress handling practices and providing immediate access to water post-transport are highly recommended (Kannan *et al.*, 2022; Kumar *et al.*, 2024).

Pulse rate

The mean pulse rates before transportation in P0, P1, and P2 were 92.33, 88.33, and 89.33 beats/min, respectively, and after transportation increased to 93.00, 102.00, and 96.67 beats/min, respectively (Table 1). Although pulse rate increased slightly, particularly in P1, the change was not statistically significant (repeated-measures GLM, $p = 0.414$). Organic chromium supplementation also had no significant effect.

These results suggest that the transportation process applied in this study did not induce substantial stress in Jawarandu goats. This may be attributed to appropriate transport management, including moderate distance, adequate stocking density, and proper ventilation. This supports the findings of Kumar *et al.* (2024), who stated that good management maintains cardiovascular stability in goats.

Goat temperament may also influence stress responses. Kannan *et al.* (2022) reported that calmer goats exhibit more stable physiological reactions during stressful situations. The goats in this study may have been accustomed to handling, thus reducing the stress response.

Previous studies also reported that short-duration transportation with proper handling does not markedly alter physiological parameters (Raghazli *et al.*, 2021). Similar results in kids by Martinez *et al.* (2020) showed that travel duration and handling influence stress and carcass quality, emphasizing the importance of proper pre- and during-transportation management (Kumar *et al.*, 2024; Li *et al.*, 2024).

Respiratory rate

The average respiratory rate before transportation was P0= 49.00 breaths/min, P1= 57.67 breaths/min, and P2= 47.67 breaths/min. After transportation, the values changed to P0= 65.00 breaths/min, P1= 68.67 breaths/min, and P2= 47.33 breaths/min (Table 1). Repeated-measures GLM indicated that time did not significantly affect respiratory rate (Wilks' Λ= 0.569; $F(1,6)$= 4.536; p= 0.077), and chromium supplementation had no significant effect either ($p > 0.05$).

Respiratory rate is a known stress indicator in goats, as it rises in response to heat, psychological stress, and sympathetic stimulation (Minka and Ayo, 2010; Adzitey, 2020). Goats transported under high temperatures may elevate respiration as a cooling mechanism via evaporative heat loss. Relocation stress may also increase respiration through sympathetic activation (Pascual- Alonso *et al.*, 2017; Minka *et al.*, 2023). Proper ventilation, appropriate stocking density, and acclimatization are recommended to reduce excessive increases in respiration rate.

Rectal temperature

The mean rectal temperatures before transportation were P0= 39.20°C, P1= 39.27°C, and P2= 39.50°C, and afterward were P0= 39.57°C, P1= 39.43°C, and P2= 39.47°C (Table 1). Time did not significantly affect rectal temperature (Wilks' Λ= 0.800; $F (1,6)$= 1.500; p= 0.267), and supplementation did not produce any significant effect either ($p > 0.05$).

Rectal temperature serves as a key indicator of thermal stress and physiological regulation during transport (Al-Dawood, 2017). Although slight increases were observed in P0 and P1, the lack of statistical significance suggests that transport conditions did not induce severe heat stress. These observations agree with Minka *et al.* (2023), who also found that short-distance transport with proper ventilation does not markedly alter core body temperature.

Goat adaptation to environmental conditions and handling may also maintain temperature stability (Pascual-Alonso *et al.*, 2017). Goats possess efficient thermoregulatory mechanisms, including increased respiratory heat loss and peripheral vasodilation, allowing them to maintain a stable core temperature in varied environments (Piccione *et al.*, 2013).

CONCLUSIONS AND RECOMMENDATIONS

Supplementation of organic chromium (Cr^{+}) at 0.5 and 1 ppm did not significantly affect physiological responses (pulse rate, respiratory rate, and rectal temperature) or reduce body weight loss in Jawarandu goats following transportation. Although transportation caused measurable physiological stress as indicated by weight loss, chromium supplementation did not alleviate these effects under the current conditions. Further studies are recommended with varying doses, forms, and durations of organic chromium supplementation, as well as different transportation conditions, to optimize physiological resilience against transport stress in goats.

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NOVELTY STATEMENT

Research on organic chromium supplementation, its effects on stress, and the resulting physiological responses has been widely conducted in large ruminants; however, it remains limited in small ruminants such as goats.

AUTHOR'S CONTRIBUTION

All authors are equally sharing.

Ethical approval

All experimental procedures involving animals were conducted in accordance with the guidelines for the care and use of laboratory/experimental animals established by the Government Regulation of the Republic of Indonesia. The experimental protocol was reviewed and approved by the Animal Ethics Committee of the Faculty of Agriculture, Universitas Lampung, Indonesia (Approval No.: [006/UNILA/KEH/EC/2025]).

Generative AI and AI assisted technology statement

The authors declare that no generative AI and AI assisted technology was used in the creation of this manuscript.

Conflict of interest

The authors have declared no conflict of interest.

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