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Reduce Heat Stress on Broilers During Transport by Supplying Drinking Water

(Mengurangi cekaman panas pada ayam broiler saat transportasi melalui pemberian air minum)

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ABSTRACT. The transportation process causes heat stress in broilers. This research aims to test the effectiveness of the drinking water supply system for broilers during transport to reduce the effects of heat stress caused by the transportation process. Broilers are grouped into four treatments: morning transport with water (T1), morning transport without water (T2), afternoon transport with water (T3), and afternoon transport without water (T4). Results show that broilers consume more water (317.26 ml/bird/hour) during morning than during afternoon transport (61.53 ml/ bird/hour). However, these numbers are estimated to be lower, with water spillage contributing to the high consumption, especially during morning transport. Rectal temperature for birds is lower in T1 and T3 broilers compared to T2 and T4 broilers, although still within normal range. A decrease in hematocrit and blood glucose levels while still at normal levels is observed for all treatment groups. An increase in the ratio of heterophile and lymphocyte (HL ratio) is observed within the normal range except for T1. Percentage of body weight loss is lower on broilers with access to water: T1 (3.5%) and P3 (4.4%) compared to broilers without access to water: T2 (4.0%) and T4 (5.0%) in the same time of transport although not statistically significant (P>0.05). Based on weight loss percentage, it can be concluded that water intake during transport has some effectiveness in reducing heat stress with the best results shown on broilers transported in the morning with drinking water.

Keywords: broiler, drinking water, heat stress, transportation, weight loss

ABSTRAK. Proses transportasi menyebabkan ayam mengalami cekaman panas. Penelitian ini bertujuan untuk mengkaji efektivitas pemberian air minum selama transportasi dalam upaya mengurangi dampak cekaman panas dan meningkatkan kesejahteraan hewan dengan cara mengurangi dehidrasi dan cekaman yang disebabkan proses transportasi pada ayam broiler. Ayam dikelompokkan menjadi empat perlakuan: transportasi pagi dengan air minum (T1), transportasi pagi tanpa air minum (T2), transportasi siang dengan air minum (T3), dan transportasi pagi tanpa air minum (T4). Hasil menunjukkan ayam lebih banyak mengonsumsi air (317,26 ml/ekor/jam) pada transportasi pagi daripada transportasi siang (61,53 ml/ekor/jam). Namun, nilai ini diestimasi lebih rendah dari yang didapatkan, dengan air yang tumpah berkontribusi terhadap tingginya konsumsi air, terutama pada transportasi pagi hari. Suhu rektal lebih rendah pada broiler T1 dan T3 dibandingkan T2 and T4 namun berada dalam rentang normal. Penurunan kadar glukosa darah dan hematokrit terjadi pada seluruh perlakuan. Peningkatan rasio HL terjadi pada seluruh perlakuan kecuali T1. Persentase penurunan bobot badan lebih rendah pada ayam yang diberi air minum-T1 (3,5%) dan-T3 (4,4%) dibandingkan dengan ayam yang tidak diberi air minum-T2 (4,0%) dan-T4 (5,0%) pada waktu transportasi yang sama meskipun secara statistik tidak signifikan (P>0,05). Berdasarkan perbedaan persentase penurunan bobot badan, dapat disimpulkan bahwa konsumsi air mengurangi dampak cekaman panas yang dialami ayam broiler selama transportasi dengan hasil terbaik didapatkan pada transportasi pagi dengan air minum.

Keywords: air minum, broiler, cekaman panas, penurunan bobot badan, dan transportasi

INTRODUCTION

Animal's welfare is a concept in which animals have the same rights as humans, for example, access to food and water, free from pain and stress, and able to express normal behavior (Thaxton *et al.*, 2014). Violations of animal welfare during the transportation process of broiler chickens can lead to stress, injury, exhaustion, morbidity, and mortality. These conditions are caused by several factors such as microclimatic conditions, noise, vibration, terrible handling, transport density, and food and drink deprivation (Schwartzkopf-Genswein *et al.*, 2012). In addition to philosophical issues, animal welfare is also a business issue because its levels, such as stress levels and injury and mortality rates, directly affect the economic value of the final product.

Stress is the body's response to disturbance in the body's homeostasis,–which is affected by the type of stress, intensity, duration, and body condition. Stressors can be internal or external such as microclimatic conditions (Purwadi *et al.*, 2018). Increased glucocorticoid hormones in blood plasma show the body's response to stress.

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Stress response starts with the secretion of corticotropin-releasing hormone (CRH) from the hypothalamus and is stimulated by physical trauma, emotional trauma, or individual diurnal rhythm. The hypophysis reacts to CRH by secreting adrenocorticotropin hormone (ACTH), which stimulates glucocorticoid secretion from the adrenal cortex. Glucocorticoid hormones affect the cardiovascular system, metabolism, muscles, immune system, and behavior by stimulating or inhibiting certain hormone functions, preventing over-reaction by the body, and avoiding injury (Johnson *et al.,* 1992).

Broilers are very susceptible to heat stress. The ideal temperature for broiler transportation ranges between 26-27 ºC (Frandson, 1992), with temperatures over this limit strongly causing heat stress. The adverse effects of heat stress can be seen in changes in physiological responses, weight loss, and death due to hyperthermia. (Vecerek *et al.,* 2016; Caffrey, 2017; Chauvin, 2011). In addition to stress indicators, weight loss is also an economic loss (Brossi *et al.,* 2018).

Thermoregulation can cause body weight loss by dehydration and muscle glycogen breakdown (Adamczuk *et al.,* 2013) due to its high energy and water requirement. Stress experienced by broilers stimulates adrenaline secretion, which binds α-adrenergic and inhibits insulin secretion and glucogenesis, and stimulates glycogenolysis and glycolysis in muscles (Sargsyan and Herman 2019). This process causes a reduction in muscle mass and increased blood glucose levels.

Blood hematocrit levels are a ratio of red blood cells in blood serum, with the normal amount being 22-35%—(Wakenell 2010). An increased hematocrit level indicates dehydration or an increase in the red blood cell ratio. A decrease in hematocrit level suggests a reduction of red blood cell count in blood plasma. Abnormal hematocrit levels indicate disturbance in the blood's ability to transport oxygen and release heat.

Water is an essential component in the body's thermoregulation process. Broilers lose a lot of body fluids to release heat under heat stress conditions (Bruno 2011) and increase their water consumption. Broilers have no access to water for the duration of the transportation process, which causes dehydration and weight loss due to the inability to replenish body fluids used for thermoregulation.

Data for broiler water consumption during transportation have not yet been found. Still, they can be estimated by the correlation between the increase in water consumption and heat stress conditions in rearing. Bruno (2011) found that broilers reared at 34 °C consume more water (17.85±1.74 ml/bird/hour) than those reared at 25 °C (13.98±1.45 ml/bird/hour). This shows that heat stress causes an increase in water consumption. This study is conducted because of the lack of research about broiler water consumption during transport and its effects. It examines the effectiveness of supplying water during transport and its impact on reducing heat stress.

MATERIALS AND METHODS

Transportation

The equipment used six crates, a barrel, 30 nipples, pipes, 8 data loggers, a truck, a digital scale, digital rectal thermometers, syringes, and vacuum tubes with EDTA (ethylene diamini tetraacetic acid) anticoagulant, glucose analysis kit blood, and a cool box. Three crates were modified with a drinking water supply system in the form of nipples and pipes. A data logger was used to measure the temperature and humidity of each crate during transportation. A syringe was used to take blood samples for blood glucose levels, heterophile/lymphocyte ratios, and blood hematocrit levels analysis. The materials used 20 male broiler chickens aged four weeks with an average body weight of 1.5 kg and drinking water. The blood collection and analysis materials were distilled water, 70% alcohol, ETDA anticoagulant, and Giemsa dye.

Chickens were loaded into crates with a density of 10 birds/crate and loaded onto the truck. The crates for drinking water treatment were connected to the water barrel, and a data logger was attached to each crate. Transportation was carried out within Bogor for 3 hours, starting from departure via the route to Pasar Parung. After 90 minutes, the truck changed the route to Darul Qur'an and Cibanteng, then returned to Kandang C, Faculty of Animal Science, IPB, when the transport duration nears three hours. Transportation was carried out at two different times, at 03.02 and 13.50 WIB.

Measurements of body weight, rectal temperature, and blood collection were measured before and after transportation. Blood samples were taken using a syringe or syringe. 0.5-1 mL of blood was taken from the brachial vein on the underside of the wing. The blood was then put into a vacuum tube with ETDA anticoagulant, homogenized, and into a coolbox. Temperature and humidity were recorded using a data logger at 10-minute intervals. THI was calculated by the formula: THI = 0.85 T_{db} + 0.15 T_{wb} (Tao and Xin, 2003), where THI = Temperature Humidity Index, Tdb = Dry Bulb Temperature, and Twb = Wet Bulb Temperature.

A digital thermometer was inserted into the rectum of broiler chickens to obtain rectal temperature. Body weight loss was obtained by subtracting body weight after transport from before transportation. Mortality was obtained from the number of dead chickens during transportation divided by the total number of loaded chickens multiplied by 100%. Water consumption was obtained from the reduction in the volume of water within the water barrel.

Treatment and Data Analysis

The treatment was a combination of transportation time and drinking water. The treatments consisted of morning transportation with drinking Water (T1), morning transportation without drinking water (T2), afternoon transportation with drinking Water (T3), and afternoon transportation without drinking Water (T4). The study used a completely randomized design (CRD) with four treatments repeated three times each. Physiological response data were analyzed descriptively, and production performance data were subjected to analysis of variance. Significant differences were further analyzed with the Tukey Test.

Blood Sample Analysis

Blood samples were analyzed at the Meat and Work Livestock Nutrition Laboratory, Department of Animal Nutrition and Feed Technology, Bogor Agricultural University. The variables analyzed from blood samples were the ratio of heterophile and lymphocyte (the HL ratio), hematocrit levels, and blood glucose levels. The calculation of the HL ratio was obtained from the percentage of total heterophils and lymphocytes (Sastradipraja, 1989). The hematocrit level was obtained by dividing the erythrocyte volume by the blood serum volume. Hematocrit values were observed using a micro-hematocrit reader (Sastradipraja, 1989). Blood glucose levels were measured using a glucose kit (GlucoDr). Fresh blood samples of broiler chickens were dripped on strips and analyzed by kit.

RESULTS AND DISCUSSION

General Conditions

Data regarding the micro climatic condition during the transportation is shown in Table 1. Temperatures during morning transportation range from 23.3-25.2 ºC (inside the crates) and 26.8 ºC (outside the crates); this is below the general transport temperature of 26-27 ºC (Frandson, 1992) and is close to the ideal temperature for rearing in cages (18-24 ºC). Humidity ranges from 80.72-89.10% inside the crate and 81.03% outside. Humidity during the transportation is above the ideal transportation humidity of 50-75% (Scanes *et al*., 2004), especially in crates with drinking water. The THI value is between 23-26, indicating that the chickens are starting to experience heat stress (Purswell *et al*., 2012). The standard deviation of THI for morning and afternoon ambient was not applicable because this value is obtained from single data.

Table 1. Microclimatic condition during transport

Treatment	Temperature (ºC)	Rh (%)	THI (ºC)
T1	23.87±0.51	87.98±1.23	23.63±0.50
T2	24.63±0.64	84.43±1.96	24.32±0.59
T3	33.23±0.70	56.20±0.99	32.18±0.68
T4	33.50±0.43	56.62±1.60	32.46±0.41
Morning Ambient	26.80±1.46	81.03±3.52	26.41*
Afternoon Ambient	33.40±0.73	51.82±3.90	32.22*

* = Standard deviation of THI for morning and afternoon ambient was not applicable

The temperature inside the crate during the day is 32.6-34.3ºC, while the ambient temperature is 33.4ºC; all are above the comfort zone, with humidity during transportation in the ideal range of 50%-75%. The THI value during daytime transportation is 31.5-33. This value means that the chickens experience severe heat stress during transport (Purswell *et al*., 2012). The temperature in the crate at both times of transportation is lower or equal to the ambient temperature. This result can be influenced by several factors, one of which is wind flow. The condition of the open body of the vehicle causes more wind to enter from the front and exit from the rear of the body (Burlinguette *et al*., 2012), releasing heat out.

Water Consumption

Observations results of drinking water consumption during transportation are presented in Table 2. The data obtained indicate that chickens transported in the morning consume up to 5 times more water than those transported during the day. Bruno (2011) reported that chickens reared at 25 °C each consumed 13.98±1.45 ml of water (83.88 ml/bird/hour), while chickens reared at 34 °C each consumed as much as 17.85±1.74 ml (107.7 ml/bird/hour), showing those under higher heat stress drinks more water. Compared to the research by Bruno (2011), water consumption during morning transport is very high compared to it during day transport.

According to the Cobb Management Guide (2012), daily water consumption is 2:1 of feed consumption or 308 ml per day in broilers with an average body weight of 1.5 kg. Thus it is predicted that chickens in this research do not entirely consume the reduction in the volume of water in the water tank, but some water is wasted or scattered. Waste of water can be caused by the conditions of transportation and movement of chickens. Chickens transported in the morning experienced a lower stress intensity than chickens transported during the day so they could move more. Their body can press the nipple when they move, resulting in wasted water, which makes the water volume reduction in the morning look unrealistically high.

Table 2. Water consumption during transport

Transport time	Water volume (ml)		Water consumption (ml)		
	Before	After	Total	per Birds	Birds/hours
Morning	85200	54900	30300	1010	317.27
Afternoon	85000	79000	6000	200	61.53

Physiological Response

The physiological responses observed were rectal temperature, hematocrit levels, HL ratio, and blood glucose levels. Physiological responses before and after transportation are presented in Table 3.

Broiler chickens respond to high environmental temperatures by increasing blood flow to the skin, especially in areas not covered with feathers, to facilitate heat released through conduction, convection, and radiation. An increase in the blood flow rate that carries body heat causes an increase in the temperature of the chicken's body parts, such as the chest, legs, and rectum. Chickens treated with drinking water have a lower rectal temperature than those without water at the same transportation time. These results indicate that chickens are given drinking water release heat more efficiently than those not. Physiologically, providing drinking water during transportation positively impacts and can reduce heat stres.

Table 3. Physiological response before and after transport

Parameter	Transport	Treatment			
		T1	T2	T3	T4
Rectal Temperature (ºC)	Before	41.0±0.4	41.6±0.0	42.2±0.1	41.6±0.7
	After	40.7±0.1	41.1±0.3	41.9±0.7	42.5±0.4
Hematocrit (%)	Before	28.6±2.3	24.0±2.6	23.8±1.2	25.0±2.0
	After	17.3±3.0	20.3±6.5	22.6±5.5	15.8±10.1
HL Ratio(%)	Before	0.42±0.04	0.41±0.06	0.32±0.02	0.43±0.14
	After	0.29±0.18	0.45±0.06	0.52±0.21	0.48±0.29
Blood Glucose	Before	260.5±30.3	249.8±22.0	258.6±13.8	236.6±15.8
(mg dL^{-1})	After	208.6±2.9	231.6±14.6	258.5±20.3	229.8±49.3

The decrease in hematocrit levels occurs in all transportation treatments. The hematocrit value found in this study is below the standard 22%-35%, according to Wakenell (2010). Olanrewaju *et al*. (2010), in their research, found that chickens experiencing heat stress showed a significant decrease in hematocrit levels. Skomorucha and Sosnówka-Czajka (2017) observed that chickens exposed to high environmental temperatures experienced a decrease in hematocrit levels. Aengwanich (2007) stated that heat stress causes hemolysis, decreasing the number of red blood cells in the blood and the hematocrit level.

Blood glucose levels increase when chickens experience heat stress. The stress experienced will increase glucocorticoid hormones' secretion, which inhibits insulin secretion, stimulates glucose breakdown, and reduces glucose absorption into tissues, which causes an increase in blood glucose levels. The results showed that the blood glucose levels of broiler chickens in all treatments decrease a little except for chickens transported in the morning with drinking water. These results indicated that the stress experienced by T1 chickens was mild and did not stimulate glycogen mobilization and a significant increase in blood glucose levels.

The HL ratio increased in all treatments except T1. According to Reece and Swenson (2015), the normal HL ratio in broilers ranges from 0.45-0.55%. Heat-stressed chickens will experience an increase in the HL ratio. The secretion of epinephrine stimulates ACTH secretion, which then stimulates the adrenal cortex to secrete glucocorticoid hormones. Glucocorticoid hormones stimulate the maturation and release of neutrophils into the bloodstream and inhibit lymphocyte production (Ronchetti *et al.*, 2018). This results in a high HL ratio (Aengwanich, 2007). Heat stress could also cause the weight of lymphoid organs like the Fabricius bursa to decrease and reduce lymphocyte production (Wicaksono *et al.,* 2020). A significant increase was not found in this study, and the HL ratio of broilers in all treatments was within the normal range.

Bodyweight Loss

Body weight before and after transportation can be seen in Table 4. Broilers transported with drinking water treatment (T1 and T3) experienced lower body weight loss than broilers transported without drinking water (T2 and T4) at the time of transportation, although not statistically significant (P>0.05). These results indicate that the provision of drinking water reduces body weight loss during transport.

Table 4 Bodyweight before and after transport and bodyweight loss

Parameter	Treatment			
	T1	T2	T3	T4
BW before (g)	1534.4±13.3	1527.5±27.1	1556.1±5.0	1541.1±6.0
BW after (g)	1497.6±16.8	1466.2±27.6	1487.5±4.7	1464.1±3.6
BW loss (g)	54.8±3.6^{a}	61.3±1.5^{ab}	68.6±1.3^{bc}	77.0±8.7^{c}
BW loss (%)	3.50±0.27	4.00±0.14	4.40±0.08	5.00±0.56

BW: bodyweight

During transport, the body weight decreases due to the large amounts of energy used for the thermoregulation process. The process of thermoregulation also uses the body's water reserves as a medium to release heat. Dehydration due to lack of access to water during transportation reduces the body's thermoregulatory ability (Afnan *et al.*, 2016) and exacerbates heat stress experienced. Access to drinking water allows the chickens to replace the body water reserves to lower heat stress and reduce body weight loss.

Loss of body weight is directly related to economic value (Widyasari *et al.*, 2021). Provision of drinking water during transportation reduces the percentage of body weight loss, then predictively decreases profits damage. It would be possible to add anti-stress additives to the drinking water but consider the supplement's potential residue since the birds are given water before slaughter. Hence, plant extracts such as *jaloh* (*Salix tetrasperma Roxb*) leaves in drinking water will be an interesting further study to mitigate heat stress on broilers during transportation. Delivering this plant extract in drinking water during the grower/finisher of raising broilers can reduce the risk of heat stress on these birds, as reported by Zulfan *et al*. (2022).

CONCLUSION

Facilitating a drinking water supply during transportation can reduce the impact of heat stress on broiler chickens. Body weight loss reduces when the broilers transported by supplying drinking water compared to those without drinking water. Therefore, the best mitigation of heat stress on broilers during transportation is to transport the birds in the morning by facilitating drinking water

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