Reducing Negative Effect of Heat Stress In Broiler Through Nutritional And Feeding Strategy

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Abstract. The broiler is the main meat supplier in Indonesia. The consequences of a tropical country, Indonesia has a high ambient temperature. High ambient temperature in the tropical country is one of the main factors which resulted in broiler exposed by heat stress. One of the important ways to reduce heat stress impact in broiler is through the nutritional and feeding strategy. The objective of the recent study is to review the ways of reducing the negative effect of heat stress in broiler through a nutritional and feeding strategy. The result of the study resulted that heat stress has many negative effects on production performance, health, physiology, reproductive profile, physiological response, and immune response of broiler. These many negative effects of heat stress can be an obstacle in meat chicken production in Indonesia. Therefore, it is important to promote the ways of minimizing the negative effect of heat stress as part of ways to support improving production efficiency in broiler production. It has been concluded that there are several nutritional and feeding strategies that promote to reduce the negative effect of heat stress in the broiler. There are several ways to reduce heat stress in the broiler, i.e., applying wet feeding, free-choice feeding, diurnal feeding patterns, and feeding coarser diets, the use of feed additive, vitamin, mineral, and antioxidant.

1. Introduction

The broiler is the main meat supplier in Indonesia. It is because broiler meat production is the livestock that has the fastest time in harvesting than any other type of livestock production. Therefore, broiler production is an important thing in Indonesia which have to maintain to keep animal protein supply sustainability in Indonesia. As a tropical country, Indonesia has a high ambient-temperature which stimulates heat stress to the broiler. High ambient-temperature is the main constraint of chicken production in the tropical country that constraint to achieve high production. Heat stress is the main caused factor of economic loss in broiler production [1]. Several researchers reported that the range temperature which supports the maximum broiler growth is 10-22°C, meanwhile, the optimum temperature that supports maximum feed efficiency for broiler is 27°C, furthermore, the best temperature for broiler growing phase is 18-22°C [2, 3]. Stress in an animal is a biological response that shows the threat and disrupts homeostasis which harms animal welfare [4]. Heat stress in broiler chickens occurred when the broiler body producing or absorbing more heat than the heat released from their body. The primary source of heat in the broiler housing facility is the external temperature of the air, heat from the birds themselves, heat emission from roofs and walls. In Indonesia, the broiler is more likely to be kept in open house systems. This system makes the temperature in the broiler farms did not achieve the broiler comfort temperature. Accordingly, this makes the broiler exposed to heat stress. Yalcin et al. (1997) stated that high ambient temperature reduces broiler performance including increased mortality rate [5, 6]. Heat
stress decreased the digestibility of dietary nutrients (proteins, fats, starch) [7]. Meanwhile, in young chickens, heat stress reduced antibody production [8]. Heat stress in poultry changed the physiology, behavior, and biochemistry of poultry which all doing to reestablish homeostasis [9].

Several signs show poultry hit heat stress, i.e., increased water intake, decreased appetite, increased cannibalism, panting with open mouth, squatting near to the ground and elevating wings, droopy, slowness, lethargic closed eyes, lying down, decreasing production [10]. There are several ways of poultry to release heat, i.e., through the body cooling process through a process of evaporation, releasing water via increasing breath, increasing gasping action, and increasing moving their feathers, reducing feeding activity, reducing the activity of moving, and using much time for resting [11]. Many researchers reported that there are several ways to prevent heat stress of poultry, i.e., through a genetic approach, housing management, conditioning of thermal, and through feed and nutrition approach [12, 13, 14, 15]. The approaches of nutritional aspect and feeding management showed can reduce the heat stress of broilers. To support the improvement of chicken meat production in Indonesia [16]. So, It is important to study how the ways to reduce the negative effect of heat stress in a broiler, so that it can help the broiler farmers in Indonesia to minimize the occurrence of heat stress in their broiler. Hopefully, this study contributes to an increase in chicken meat production in Indonesia. The objective of the recent study is to review the ways to reduce the negative effect of heat stress in broiler through a nutritional and feeding strategy.

2. Source And Mechanism Of Heat Stress In Broiler

The broiler is classified as homeothermic animals with specific features that do not have sweat glands and almost all parts of their body are covered in fur. These biological conditions cause broiler in high temperatures to have difficulty removing body heat into the environment. One of the primary source of heat in the broiler body come from their body heat. Broiler body temperature directly increased in line with the environment temperature. The body temperature of broilers is largely determined by the temperature of the environment [17]. Heat stress resulted from the unbalances of energy released from the animal body to the environment with heat energy resulted from their animal body itself. Several factors caused the unbalances of that energy, i.e., the first is external factors (air temperature, humidity, thermal irradiation, sunlight) [18]. The second is an internal factor (metabolism rate, species, and thermoregulatory mechanisms of an animal). Caused factors which affect broiler tend to easy exposed by heat stress that is because the broiler as a product of intensive genetic selection that aims to achieve high growth, has a side effect in the term of low ability in adapting with extreme environmental conditions [19]. Normal body temperature in poultry ranged between 40.5-41.5°C [20]. So, to be able to live comfortably at this temperature, broilers must be maintained at a temperature that is comfortable for them. Some researchers revealed that three-week-old broiler chickens must be maintained in environments with temperatures ranging from 20-25°C and relative humidity of around 50-70% and 26-27°C for adult broilers [21, 22]. The maintenance of broilers above the comfortable temperature range, causing broilers to suffer stress because of the difficulty of throwing body temperature into the environment [23]. The high temperature of the environment causes changes in broiler behavior and affects the function of several broiler’s organs, such as respiratory organ, heart, which then affects the increase in corticosterone and cortisol hormones, and decreases the hormone adrenaline and thyroxine in the blood [24]. There are several ways of animals to maintain their homeostasis conditions under a high-temperature environment, i.e., first, conduction, second, convection, third, evaporative heat loss by vasodilatation and perspiration [25].

The first response of livestock when heat stress occurs is to directly activate the neurogenic system, which is characterized by an increase in blood pressure, muscle, nerve sensitivity, blood sugar, and respiration [26]. The next response is done when the first response fails to dispel heat stress. In the next response, the livestock body will activate the hypothalamic-pituitary-adrenal cortical system. The hypothalamus will produce corticotrophin-releasing factors, which in turn stimulate the pituitary for the release of corticotropin hormone Adreno (ACTH) [26]. ACTH
secretion caused adrenal cortical tissue cells to proliferate to release corticosteroids. Corticosterone concentrations in blood were used to determine stress levels in poultry [27]. Furthermore, other hormones that also experience changes due to increased body temperature are the hormone thyroxine and adrenaline, where both activities are reported to decline at high ambient temperatures [20].

3. The Effect Of Heat Stress In Broiler

Many studies have done to evaluate the effect of heat stress on the broiler, i.e., to production performance, health, physiology, reproductive profile, physiological response, and immune response. The negative effect of heat stress on broiler production performance has been shown that heat stress significantly reduced feed efficiency up to 25.6% through reducing body weight achievement [24]. It is because heat stress made a negative effect on nutrient metabolism which affected reducing the growth of muscle [28]. The negative effect of heat stress on broiler performance also suspected caused by the negative effect of heat stress on gut health. Environment temperature is one of the caused factors which affecting gut health including gut microbial ecosystem. Furthermore, gut health related to nutrient absorption which affecting the numerous nutrient that using for growth [29]. Heat stress has a negative effect on meat quality which is shown in higher fat deposition [30]. Heat stress reported affecting high mortality in a broiler [31]. Meanwhile, the increasing temperature in poultry house reduced feed intake [32]. Heat stress reported has a negative effect on the reproductive efficiency of poultry [33]. The kinds of negative effects of heat stress on the reproductive efficiency of poultry are reducing the size of reproductive organs, decreasing the secretion of the gonadotropin-releasing hormone (GnRH), and delaying the process of ovulation. Reproductive efficiency related to the profitability of poultry production systems. High ambient-temperature reported as one of the kinds of factors which affect the quality and fertility of semen in broiler breeder [34]. Furthermore, heat stress affected teratogenic (birth) defects in chicks which caused by damaging of development and growth of chick embryo [35]. Several researchers stated that heat stress reported has a negative effect on poultry immune status which is proven through reducing lymphoid organ weight of chicken, reducing the systemic humoral responses, and reducing the ratio of circulating antibodies, IgG and IgM [18,36]. Heat stress has proven to decrease the ability of phagocytic of macrophages, reducing macrophage basal and oxidative burst in broilers [37]. Lara and Rostagno (2013) stated that heat stress increased the ratio of heterophil to lymphocyte [18].

4. Reducing Heat Stress In Broiler Through Nutritional And Feeding Strategy

The important thing to reduce heat stress in the broiler is lowering body heat through feeding strategies [38]. It is because body heat resulted due to using dietary energy related to nutrient utilization in the body. Therefore, lower body heat can be realized by feeding strategies. There are several concepts related to feeding strategy which reducing body heat, i.e., reducing heat increment, catabolism of fewer nutrients above needed or increasing the digestion of nutrient. Achieving this concept can be achieved which several ways, such as applying wet feeding, free-choice feeding, diurnal feeding patterns, and feeding coarser diets [38]. One of the feeding strategies to reduce heat stress in broiler is giving broiler diet in pellet form. It has occurred because pellet form reduced feeding time and saving energy [38]. Giving a larger particle size pellet in high temperatures have been shown reduced body heat production through minimizing feeding time [39]. Giving diet in wet mash form to heat-stressed broiler improved feed utilization better than giving in the dry mash form. It is related to being increasing dry matter intake which increases micronutrient intake as an effect of increasing feed intake. Giving a broiler diet that has content low in metabolizable energy (ME) and high in protein reported beneficial for the heat-stressed broiler [40]. Reducing heat increment can be done by using fat as a source of dietary ME better than protein and carbohydrates. It is because giving dietary ME sources from fat diet to heat-stressed broiler has been reported reducing the rate of feed passage in which affecting improvement nutrient using [41]. One of the negative effects of heat exposure to broiler is changing the acid-base balance. Therefore, supplementing minerals that have a
role in the acid-base balance of body fluids reported has beneficial for the heat-stressed broiler. There are several key mineral elements which have a role in those function, i.e., Sodium (Na), potassium (K) and chlorine (Cl) [42]. Benefits of supplementing Na, K, and Cl mineral to diet and drinking water of heat-stressed broiler are increasing water consumption which cooling down the body, facilitating heat dissipation, and supporting blood electrolyte balance normalization [43].

Addition several vitamins to drinking water has been reported as a beneficial effect on the heat-stressed broiler. There are several vitamins which reported has those functions, i.e., vitamins C, A, D, E, and B complexes [44]. The use of ascorbic acid given the positive impact to the heat-stressed broiler [45]. The other feeding strategy to overcome heat stress in the broiler is giving feed in cooler periods (early morning or evening), conversely, withdrawal of feed in the hot period. This feeding strategy has been reported that has a positive impact on heat-stressed broiler [46]. Method of free choice feeding reported giving a positive impact in lowering heat increment [47]. It is because the broiler can select from various feed ingredients to meet their nutrient requirements. Therefore, the free-choice feeding method has benefits for the heat-stressed broiler. In the condition of heat stress, broiler consumed water more than feed. Therefore, several factors related to water consumption influences the heat-stressed broiler. Several factors influenced drinking water consumption, i.e., drinker type, water temperature, height and shape of a drinking tool [46]. The addition of feed additives in the diet gave a positive impact on heat-stressed poultry particularly probiotic [18]. Probiotic has beneficial to heat-stressed broiler because increasing performance through improving intestinal morphology and structure, immune system, and physiological conditions of the heat-stressed broiler [48]. Several reports showed that supplementation of mineral has a positive impact on the heat-stressed broiler. Supplementation 4.5 mg/kg of zinc improved the performance of the heat-stressed broiler [49]. Meanwhile, supplementation of 120 ppb chromium improved the performance of the heat-stressed broiler [50]. Heat stress suppresses host anti-oxidant defense systems of poultry, furthermore decreased antioxidant status [51]. Therefore, exogenous antioxidant supplementation is one of the ways to reduce heat stress in a broiler. Using herbal plant which has a high content of antioxidant reported has a good function in the reduced negative effect of heat stress in poultry [52].

5. Conclusion
Heat stress is the main obstacle in broiler production in a tropical country including Indonesia. High ambient temperature in the tropical country is one of the main factors which resulted in broiler exposed by heat stress. Heat stress has a negative effect on broiler production. One of the important ways to reduce heat stress impact in broiler is through the nutritional and feeding strategy. Based on the nutrition aspect, body heat produced as a result of the use of nutrients in the body. Therefore, reducing heat stress can be done through nutritional and feeding strategies. This review showed several technics of nutritional and feeding strategy which promotes to induce the reduction of heat stress in the broiler. There are several ways to reduce heat stress in the broiler, i.e., applying wet feeding, free-choice feeding, diurnal feeding patterns, and feeding coarser diets, the use of feed additive, vitamin, mineral, and antioxidant.

References
[1] Benton CE, Balnave D, Brake J, Pas. 1998. Review: The Use of Dietary Minerals During Heat Stress in Broilers. The professional animal scientist 14 :193-196.
[2] Charles DR. 2002. Responses to the thermal environment. In: Charles and Walker (eds) Poultry Environment Problems, a guide to solutions. Nottingham Univ. Press, UK, 1-16.
[3] Kampen MV. 1984. Physiological responses of poultry to ambient temperature. Archiv für Experimentelle Veterinärmedizin, 38: 384-391.
[4] Moberg GP. 2000. Biological response to stress: Implications for animal welfare. In: Moberg GP, Mench JA, editors. Biol Anim Stress. Oxfordshire (UK): CABI Publishing. p. 1-21.
[5] Yalcin S, Settar P, Ozkan S, Cahaner A. 1997. Comparative evaluation of three commercial broiler stocks in hot versus temperate climates. *Poultry Science* 76: 921-929.

[6] Garriga C, Hunter RR, Amat C, Planas JM, Mitchell MA, Moreto M. 2006. Heat stress increases apical glucose transport in the chicken jejunum. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology* 290: R195-201.

[7] Bonnet S, Geraert PA, Lessire M, Carre B, Guillaumin S. 1997. Effect of high ambient temperature on feed digestibility in broilers. *Poult. Sci.* 76:857–863.

[8] Zulkifi I, Norma MT, Israf DA, Omar AR. 2000. The effect of early age feed restriction on subsequent response to high environmental temperatures in female broiler chickens. *Poult. Sci.* 79:1401–1407.

[9] Sahin K, Sahin N, Kucuk O, Hayirli A, Prasad AS. 2009. Role of dietary zinc in heatstressed poultry: A review. *Poult. Sci.*, 88: 2176–2183.

[10] Dayyani N, Bakhtiyari H. 2013. Heat stress in poultry: background and affective factors. *International journal of Advanced Biological and Biomedical Research*. 1(11): 1409-1413.

[11] Mack LA, Felver-Grant JN, Dennis RL, Cheng HW. 2013. Genetic variation after production and behavioral responses following heat stress in 2 strains of laying hens. *Poult. Sci.*, 92: 285-294.

[12] Gowe RS, Fairfull RW. 2008. Breeding for resistance to heat stress, in: DAGHIR, N.J. (Ed.) Poultry Production in Hot Climates Vol. pp. 13-29 (CAB International, Cromwell Press, Trowbridge).

[13] Yahav S, Strauschnow A, Luger D, Shinder D, Tanny J, Cohen S. 2004. Ventilation, sensible heat loss, broiler energy, and water balance under harsh environmental conditions. *Poultry Science* 83: 253-258.

[14] Yahav S, McMurtry JP. 2001. Thermotolerance acquisition in broiler chickens by temperature conditioning early in life-the effect of timing and ambient temperature. *Poultry Science* 80: 1662-1666.

[15] Ahmad T, Sarwar M. 2006. Dieatry electrolyte balance: implications in heat stressed broiler. *World's Poultry Science Journal* 62: 638-653.

[16] Suganya T, Senthilkumar S, Deepa K, Amutha R. 2015. Nutritional management to alleviate heat stress in broilers. *International Journal of Science, Environment and Technology*. 4(3) : 661 – 666.

[17] Lin H, Zhang HF, Du R, Gu XH, Zhang ZY, Buyse J, Decuyper P. 2005. Thermoregulation responses of broiler chickens to humidity at different ambient temperatures. II. Four weeks of age. *Poult Sci.* 84:1173-1178.

[18] Lara LJ, Rostagno MR. 2013. Impact of Heat Stress on Poultry Production. *Animals* 3, 356–369.

[19] Yahav S.2000.Domestic fowl-strategies to confront environmentalconditions. *Poultry and Avian Biology Reviews*,11: 81–95.

[20] Etches RJ, John TM, Verrinder Gibbins AM. 2008. Behavioural, physiological, neuroendocrine and molecular responses to heat stress. In: Daghir NJ, editor. Poult Prod hot Clim. p. 49-69.

[21] Borges SA, Fischer da Silva A V, Maiorka A, Hooge DM, Cummings KR. 2004. Effects of diet and cyclic daily heat stress on electrolyte, nitrogen and water intake, excretion and retention by colostomized male broiler chickens. *Int J Poult Sci*. 3:313-321.

[22] Czarick IIIM, Fairchild BD. 2008. Poultry housing for hot climates. In: Daghir NJ, editor. Poult Prod hot Clim. Trowbridge (UK): Cromwell Press. p. 81-131.

[23] Austic RE. 2000. Feeding poultry in hot and cold climates. In: Yousef MK, editor. Stress phsiology Livest poultry Vol III. Florida (US): CRC Press Inc. p. 123-136.

[24] Sohail MU, Hume ME, Byrd JA, Nisbeta DJ, Ijaz A, Sohail A, Shabbir MZ, Rehman H. 2012. Effect of Supplementation of Prebiotic Mannan-Oligosaccharides and Probiotic Mixture
on Growth Performance of Broilers Subjected to Chronic Heat Stress. Poult. Sci. 91: 2235–2240.

[25] Pawar SS, Basavaraj S, Dhansing LV, Nitin KP, Sahebrao KA, Vitthal NA, Manoj BP, Kumar BS. 2016. Assessing and Mitigating the Impact of Heat Stress in Poultry. Advan. Anim. Vet. Sci. 4, 332–341.

[26] Virden WS, Kidd MT. 2009. Physiological stress in broilers: ramifications on nutrient digestibility and responses. J Appl Poult Res. 18:338-347.

[27] Sohail MU, Ijaz A, Yousaf MS, Ashraf K, Zaneb H, Aleem M, Rehman H. 2010. Alleviation of cyclic heat stress in broilers by dietary supplementation of mannan-oligosaccharide and Lactobacillus-based probiotic: Dynamics of cortisol, thyroid hormones, cholesterol, C-reactive protein, and humoral immunity. Poult Sci. 89:1934-1938.

[28] Kim HW, Cramer T, Ogbeifun OOE, Seo JK, Yan F, Cheng HW, Kim YHB. 2017. Meat and Muscle Biology Breast Meat Quality and Protein Functionality of Broilers with Different Probiotic Levels and Cyclic Heat Challenge Exposure. Meat. Muscl. Biol. 1, 81–89.

[29] Zoetendal EG, Collier CT, Koike S, Mackie RI, Gaskins HR., 2004. Molecular Ecological Analysis of the Gastrointestinal Microbiota: A Review. J. Nutr. 134, 465–472.

[30] Lu Q, Wen J, Zhang H.2007. Effect of chronic heat exposure on fat deposition and meat quality in two genetic types of chicken. Poultl. Science, 86: 1059–1064.

[31] Vecerek V, Voslarova E, Conte F, Vecerkova L, Bedanova I. 2016. Negative Trends in Transport-Related Mortality Rates in Broiler Chickens. Asian-Aus. J. Anim. Sci. 29, 1796–1804.

[32] Cheng TK, Hamre ML, Coon CN. 1997. Effect of environmental temperature, dietary protein, and energy levels on broiler performance. Journal of Applied Poultry Research 6: 1-17.

[33] Kala M, Shaikh MV, Nivsarkar M, 2017. Equilibrium between AntiOxidants and Reactive Oxygen Species : A Requisite for Oocyte Development and Maturation. Reprod. Med. Biol. 16, 28–35.

[34] Riaz A, Aleem M, Ijaz A, Saeed MA, Latif A. 2004. Effect of Collection Frequency on the Semen Quality of Broiler Breeder. Brit. Poult. Sci. 45, 823–827.

[35] Noiva RM, Menezes AC, Peleteiro MC. 2014. Influence of Temperature and Humidity Manipulation on Chicken Embryonic Development. Vet. Res. 10, 2-10.

[36] Tirawattanawanich C, Chantakru S, Nimitsantiwong W, Tongyai S. 2011. The Effects of Tropical Environmental Conditions on the Stress and Immune Responses of Commercial Broilers, Thai Indigenous Chickens, and Crossbred Chickens. Poult. Sci. 20, 409–420.

[37] Gomes AVS, Quinteiro-Filho WM, Ribeiro A, Ferraz-de-Paula V, Pinheiro ML, Baskeville E, Akamine AT, Astolfi-Ferreira CS, Ferreira AJP, Palermo-Neto J. 2014. Overcrowding Stress Decreases Macrophage Activity and Increases Salmonella Enteritidis Invasion in Broiler Chickens Overcrowding Stress Decreases Macrophage Activity and Increases Salmonella Enteritidis Invasion in Broiler Chickens. Avian. Pathol. 43, 82–90.

[38] Syafwan S, Kwakkel RP, Verstegen MWA. 2011. Heat stress and feeding strategies in meat type chickens. World's Poult Food Journal. 67 : 653674.

[39] Gous RM, Morris TR. 2005. Nutritional interventions in alleviating the effects of high temperatures in broiler production. World's Poult. Sci. J., 61: 463-475.

[40] Balnave D, Mutisari TM, Abdoellah. 1990. Self- select feeding of commercial pullets sing a complete layer diet and a separate protein concentrate at cool and hot temperature. Aust. J. Agri. Res., 41: 549-555.

[41] Zulkifli I, Htim Nwe Nwe AR, Alimon TC, Loh, Hair-Bejo M. 2007. Dietary selection of fat by heat- stressed broiler chickens. Asian-Australian J. Anim. Sci., 20: 245-251.

[42] Borges SA, Fischer Da AV Silva, Maiorka A. 2007. Acid-base balance in broilers. World's Poult. Sci. J.,63: 73-81.
Ahmad T, Sarwar M, Mahr-Un-Nisa, Ahsan-Ul-Haq, Zia-Ul-Hasan. 2005. Influence of varying sources of dietary electrolytes on the performance of broiler reared in a high temperature environment. Animal Feed Sci. and Technol., 20: 277-298.

Ferket PR, Qureshi MA. 1992. Performance and immunity of heat-stressed broilers fed vitamin and electrolyte-supplemented drinking water. Poult. Sci., 71: 88-97.

Kutlu HR. 2001. Influences of wet feeding and supplementation with ascorbic acid on performance and carcass composition of broiler chicks exposed to a high ambient temperature. Archiv for Tierernaehrung, 54: 127-139.

Dagher NJ. 2009. Nutritional strategies to reduce heat stress in broilers and broiler breeders. Lohmann Informat., 44: 6-15.

Yo T, Siegel PB, Faure JM, Picard. 1998. Self- selection of dietary protein and energy by broilers grown under a tropical climate: adaptation when exposed to choice feeding at different ages. Poult. Sci., 77: 502-508.

Jahromi MF, Altaher YW, Shokryazdan P, Ebrahimi R, Ebrahimi M, Idrus Z, Tufarilli V, Lian JB. 2015. Dietary supplementation of a mixture of Lactobacillus strains enhances performance of broiler chickens raised under heat stress conditions. Int. J. Biometeorol., doi:10.1007/s00484-015-1103-x.

Kucuk O, Sahin N, Sahin K. 2003. Supplemental zinc and Vitamin A can alleviate negative effects of heat stress in broiler chickens. Biological Trace Element Research 94: 225-235.

Sahin K, Sahin N, Onderci M, Gursu F, Cikim G. 2002. Optimal dietary concentration of chromium for alleviating the effect of heat stress on growth, carcass qualities, and some serum metabolites of broiler chickens. Biological Trace Element Research 89: 53-64.

Sahin K. 2015. Modulation of nf-κb and nrf2 pathways by lycopene supplementation in heat-stressed poultry. Worlds Poultry Science Journal 71: 271-284.

Dhama K, Latheef SK, Mani S, Samad HA, Karthik K, Tiwari R, Khan RU, Alagawany M, farag MR, alam GM, Laudadio V, Tufarelli V. 2015. Multiple beneficial applications and modes of action of herbs in poultry health and production-a review. International Journal of Pharmacology 11: 152-176.