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Review Article

Influence of Heat Stress and Housing on Broiler Production: A Review

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Abstract

The success of poultry production is highly dependent on prevailing climatic and environmental conditions. Heat stress is a limiting factor in broiler production in tropical regions. Heat stress causes stunted and abnormal growth as well as poor quality and safety of broiler meat. Influence of heat stress on productivity and immune response in broiler has been adequately studied. However, little research is done on the influence heat stress and housing have on poultry production. This review focuses on the research findings available on the influence of heat stress and housing in broilers.

Keywords: Heat Stress; Broiler Production; Broiler Meat

Introduction

Poultry production is one of the lucrative businesses of the livestock industry in both developed and developing countries. According to Sinha., *et al.* [1] inconsistency in non-genetic factors is known to have influence on sustainability of livestock production systems in tropical environments. Heat stress causes death of birds which results decline production performance and adversely affects the return from the enterprise. Pathogens and other disease causing organisms increase with increasing temperature; resulting in outbreak of diseases in poultry birds. Variations in climatic conditions influence the occurrence of diseases and their transmission due to increase vectors and pathogens.

Signs of heat stress in poultry

Broiler birds that have heat stress usually show signs of panting with open mouth gasping for air, the combs/wattles become pale, wallowing in any available water, fatigue, constantly drink water, convulsion in severe cases, reduced feed intake, decreased weight and increased pecking, increased output of urine and further loss of electrolytes, wet droppings developed, disturbance in bone metabolism, immunity to defend the body against diseases decreases [2]. Poultry farmers can help reduce heat stress within the birds by supplying the birds with cold water, ensuring proper ventilation within the pen, constantly changing the litter within the pen because the litter could generates a lot of heat. Birds experiencing heat stress conditions, feed less, drink more water [3].

Effects of heat stress on broiler meat

According to Dai., *et al.* [4], Imik., *et al.* [5] exposure of birds to high direct sunshine results in depression of chemical composition and meat quality in broilers industry. Heat stress causes poor meat characteristics of broiler chicken and therefore the quality of the meat is lost, especially when the birds are exposed to high temperatures during the growing phase [6]. During transportation of birds to the processing unit, birds experienced heat stress; this results in high drip loss, high pH leading to dark colour, low juiciness, poor meat safety [7]. Environmental stress like early feed withdrawal put the birds under more stress releasing halothane genes causing drastic biochemical break down of glycogen into lactic acid resulting into Pale, Soft and Exudative meat.

Fellenberg and Speisky [8] reported that heat stress causes oxidative stress. Oxidative stress generates free radicals, which react with proteins, carbohydrates, fats and cellular structures and disrupt their structure and functions. Oxidative stress has adverse effects on protein metabolism, decreasing the retention and increasing the excretion of proteins [9]. The easiest way to alleviate heat stress-induced adverse effects is to add natural or synthetic antioxidants and nutrients to the feed [10]. Heat stress adversely affects the structure and growth of muscles. According to Dai., *et al.* [4], Imik., *et al.* [5] exposure of birds to high direct sunshine leads to depression of chemical composition and meat quality in broilers industry. Exposure to high ambient temperature during the growing phase of broilers has been related with poor meat characteristics of broiler chicken and loss of quality, example it reduces drip loss in broiler meats [6]. Moreover, exposure to heat stress during transportation of birds from production farms to processing centre has led to losses of meat quality [7]. Heat stress is thought to be an element which will result into colonization of birds by pathogens, increased faecal shedding and horizontal transmission, and consequently, increased contamination risk of animal products. High heat stress increases the colonization of birds by disease causing organisms thereby reducing the security of the broiler meat; this might result in prolong stress of the bird resulting in Dark Firm Dry (DFD) meat.

Effect of heat stress on behavioural and physiological responses

Liu., *et al.* (2015) reported that birds under heat stress lie down longer than non-heat stress birds. When the authors compared the feeding behaviour, they concluded that heat stressed birds take shorter time to feed than non-heat stressed birds. Stressed birds drink more water than non-stressed birds. Birds under heat stress tends to reduce the impact of heat stress by feeding less and drink more.

Birds under heat stress tend to adjust the function of their central, metabolic and endocrine systems that controls thermoregulation. The physical features of the birds are influenced by the metabolic rate and can be used for behavioural adjustments [11]. Homeostasis is involved in an adaptive role in adaptation to adverse environmental conditions. The social and physiological behaviour of birds change to enable them maintain their body temperature and cope with the heat stress in the environment. The immune system of heat stressed birds tIn adverse climatic condition, maintaining homeostasis mechanism in birds is by heat exchange between environment and air sac through convection, evaporative heat loss, perspiration and vasodilation process [12].

Effect of heat stress on the immunological responses in birds

Heat stress has adverse effects on health status of birds leading to changes in physiology, metabolism, hormonal and immune system. High temperature decreases synthesis of Thymus and Bone-marrow lymphocytes and suppression of phagocytic activity of blood leukocytes [13]. It further decreases total white blood corpuscle (WBC) and activities of leukocytes subsequent heat exposure. Bartlett and Smith [14] found lower levels of total circulating antibodies and lower levels of specific IgM and IgG in broiler under heat stress. Zulkifi., *et al*. [15] also supported that, heat stress had significant decline in antibody production; causing variation of the immune reaction by the central nervous system (CNS) and which is mediated by a complex network of nervous, endocrine and immune systems.

Influence of deep litter system of housing on production

Birds kept on deep litter system fed better than those on grass [16]. However, birds in deep litter demonstrated high level of freight which can influence their productivity. Research conducted by Dhaliwal., *et al.* [17] revealed that purchasing birds kept on deep litter have higher laying capacity than those kept on the other bedding materials. Welfare of the bird is vital issue to consider in poultry keeping, since the welfare of the birds directly influence the health and productivity. In developing countries, poultry housing structures are built with consideration of environmental heat requirements of the birds. According to Glatz and Bella [18] birds kept in the tropical countries require minimal heat; which includes the housing structure, even though, newly hatched birds require supplementary heating. Deep litter system of housing birds give the birds total freedom to display give their normal patterns of behaviour (Ismail, 2017).

Influence of slated floor and deep litter on poultry production

One limitation of the deep litter system of housing is reduced productivity and exposure of the birds to disease condition. This limitation can be taken care of by the employment of slated floor. In slated floor housing system, the birds' feet do not get into contact with the excreta; this ensure reduced disease conditions and increase growth rate [19]. Slated floor improves/increases the welfare of the birds [20]. In deep litter system of housing, better litter management is incredibly crucial for litter quality [21]. Poor litter and ventilation put the birds at the risk of respiratory diseases and dermatitis. As a result of poultry improvement and breeding programmes that have been carried out in the last 40 - 50 years, performance of broiler chickens has improved by the developments of feeding, environmental conditions, and health improvements [22]. Also, the weight and feed conversion ratio of the birds have also been improved during the growth phase drastically [23]. Notwithstanding this fast growth rate, it has led to undesirable outcomes, which are one of the main concerns in animal welfare. Bessei [24] indicated that fast growth rate is associated with metabolic diseases, lower locomotor activity, high stocking density, and bad management of air and litter quality in the housing unit. Fast-growing broilers show higher rates of heart attack and hypoxia [25] and are more prone to behavioural disorders and immune system impairments [26]. There is a negative impact on the welfare of the birds due to the fast growth rates. Either different feeding regime is advised to control the growth rate of commercial broilers [27]. Animal welfare activists and scientists recommend deep litter system. Deep litter system is mostly used for brooding and rearing chicks and broiler however, it can also be used for rearing layer birds. Deep litter rearing helps to reduce stress in laying birds (Ismail, 2017).

Modern broiler chickens are kept in deep-litter houses with wood shavings used as bedding materials where the quality of litter material and good ventilation is ensured to prevent the well-being of the birds [28,29]. Since, broiler birds spend most of their time resting, especially after 3 weeks of age. The quality and quantity of litter influences indirectly the level of heat generated in the pen. High levels of ammonia in litter is known to cause inflammation of eyes and larynges of the birds and has a high probability of increasing the rate of mortality [30]. The growth rate of the birds may be negatively affected when the feet of the birds are in contact with manure and the litter [19]. Dermatitis in broiler chicken is caused by wet litters which significantly influence the health and the welfare status of the birds and subsequently the total profitability [30,31]. The occurrence of foot-pad dermatitis do have significant welfare and financial implications [32].

Due to the problems of poor litter management associated with deep-litter production systems, alternative floor systems is suggested in commercial broiler meat production [33]. Most poultry farmers prefer deep litter system to cages and slatted floor because of low cost of production in the usage of deep litter system. Due to the adverse effects of wet litter on the birds for instance leg deformities and breast blisters that negatively affects broiler meat quality, farmers now prefer cage systems [34]. It has been thought that slatted floors would become more popular since they have no litter cost and they minimize the negative effects of improper litter management [33,35].

Conclusion

This review focuses on the research findings available on the influence of heat stress and housing in broilers.

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Nutritional/Dietary components	Influence on microbiota	Influence on host health	Reference
Whole Grain Diet	Relative abundance of *Enterobacteriaceae* decreased; Butyrate-producing *Lachnospira* and *Roseburia* increased.	Energy balance regulation, Plasma alkylresorcinols increased and maintained body weight.	Karl JP., *et al.* [57]
Low Carbohydrate Intake	Decreases *Eubacterium rectale, Bifidobacterium* and *Roseburia* species	Unclear.	Murphy EF., *et al.* [16]
High Carbohydrate diet + High-fat +High-protein diets	Promote development of *Bacteroidetes*; Favors *Prevotella* genus.	Ferment polysaccharides and indigestible carbohydrates. Benefits the gut by SCFAs production.	G.D. Wu., *et al.* [53]; Rajoka MSR., *et al.* [17]
High protein diet	Causes riched *Bacteroides* associated enterotype. Reduce *Firmicutes*.	Decrease in weight	David La., *et al.* [52]; G.D. Wu., *et al.* [53]
High Fat Diet and High Calorie/ Western Diet	Progressive increase in *Firmicutes* [*Mollicutes* sp] and Reductions in *Bacteroidetes*. No relation to markers of energy harvest.	Obesity leading to decrease in the gut microbiota diversity. Metabolic Pathways	Murphy E F., *et al.* [16]; Turnbaugh PJ., *et al.* [54]; Shen W., *et al.* [55]
Less vegetable, fish and fruits	Reduced microbiome	Enhance of inflammation, triglyceride level, insulin resistance and low density lipoproteins cholesterol	Matijasic BB., *et al.* [56]
Gluten Free Diet	Beneficial bacteria decreased, while unhealthy bacteria increased. Reductions in polysaccharides intake.	Exerted lower production of cytokines and chemokines [TNFα, IFNγ and IL-8] and anti-inflammatory cytokines [IL-10] on peripheral blood mononuclear cells pro-inflammatory [PBMCs]. i.e. exerted lower immune stimulatory effects.	Sanz, Y [58]
High Fiber Diet/ Plant based Fibers	Influence microbial colonization. Enhance mucus and anti-microbial peptide production. Major driver of *Prevotella*-type microbiota.	Fermentation variables results in resulted in a greater short-chain fatty acid [SCFA] concentration [e.g. acetic and butyric acids], which help in regulating host metabolism, immune system, and cell proliferation	Makki, K., *et al.* [60]; Nakayama J., *et al.* [30]
Calorie restricted diet [CR] enriched with fibre and protein	Associated with A. muciniphila abundance helped in anti-inflammatory effects.	Improvement in insulin sensitivity markers and other clinical parameters in overweight/obese adults.	Dao MC., *et al.* [59]

Table 2: Studies on influence of dietary in take and its practices on gut-microbiota.