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Review Article

Stressors and Their Biochemical Indicators in Poultry

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Abstract

Stress is an important area for concern in poultry industry as it has direct impact on the production performance of poultry. There are various types of stressors that jeopardies the poultry health. We need to minimize these stress by adopting good management practices and also by analysing the various biochemical indicators that may get affected due to stress. A battery of biochemical indicators is required to be tested to assess the severity of stress in poultry. In this review we tried to pool together the various parameters that may be a good indicator to ascertain the stress conditions in poultry.

Keywords: Stressors; Stress; Poultry; Biochemical Indicator; Corticosterone.

Poultry are the birds namely chickens, ducks, quails, turkeys that are reared since ages for eggs, meat, feathers and various other products or bye-products. The word poultry originated from the French word 'Poule' which find its origin from the Latin word 'Pullus' meaning small animals.

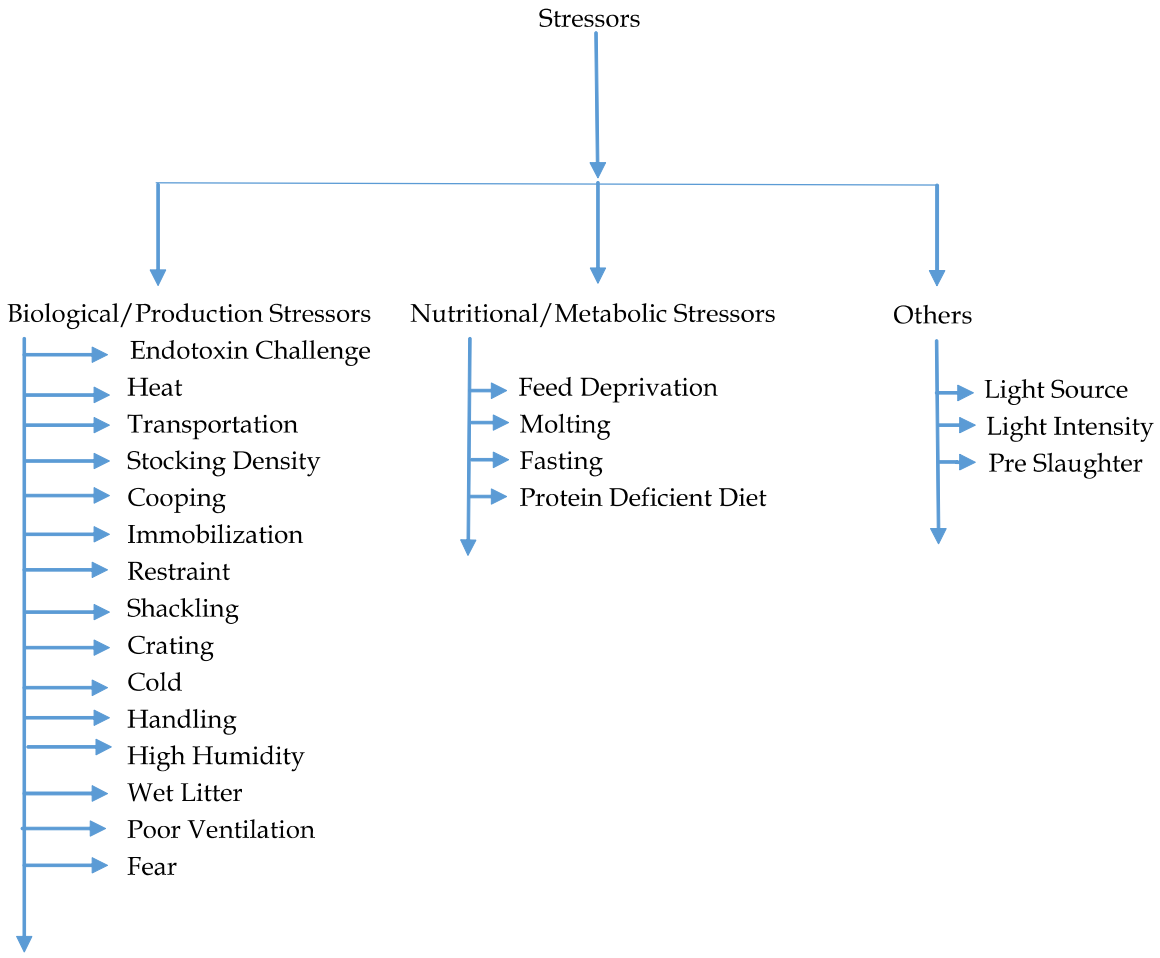
In India, poultry industry is growing at aphenomenal rate (8-10% per annum), much faster than the agricultural crops production (1.5-2% per annum). India is placed at position 3rd and 5th in the world list of largest egg and broiler producers respectively. India is emerging as the second largest market for poultry industry. The poultry industry is turning into a major backbone for the Indian economy and contribute almost 26,000 crores to the national GDP.

However, there are factors which on and often not only inflict losses to the farmers but also compromises our national economy and the most important are the stressors, that may be biological, nutritional and various others. These stressors directly affect the production capacity of the poultry. To reduce the losses due to these stressors we need to device a mechanism so as to minimize the impact of these stressors on the production output of the poultry.

If we go into the definition the "stressors are the agents that produces stress at any time" and the phenomenon is called Stress, which according to the Selye (1973) "Stress is the nonspecific response of the body to any demand". Love et al. (2013) identified four major system response to mitigate the effects of these stressors namely the Autonomic Nervous System (ANS) response, immune response, endocrine response and the behavioural response.

During the stress, there are changes in the normal levels of the various biochemical and physiological parameters, which helps us to assess the severity of stress at a given point of time.

The objective of this review is to group various stressors and to compile various biochemical parameters that may need to be studied while describing the stress conditions in the poultry.



Biochemical Indicators of Stress

Corticosterone

In poultry, the major adrenal glucocorticoid is corticosterone.There is an activation of Hypothalamic-Pituitary-Adrenal (HPA) axis due to the alteration in the activity of the neuroendocrine system of poultry caused by high environmental temperatures, cold, overcrowding, restraint, cooping, and shackling. These stressors cause an elevation in the plasma concentrations of corticosterone due to increased secretion of adrenocorticotropic hormone (ACTH) and corticotrophin releasing hormone (CRH).

There are literatures reporting different basal level of corticosterone in unstressed chickens as well as different levels during stress conditions, thereby requiring a validation of the corticosterone assays (Scanes et al. 2016). The basal concentration of corticosterone should be less than 0.3 ng/ml but as it is evident from the different studies that it may vary anywhere between 0.3 to 20 ng/ml. During stress, it may go up to the level of 150 ng/ml (Huang et al. 2014).

Adrenal Gland Ascorbic Acid Content

The adrenal glands contain large quantity of vitamin C. However, it secretes Vitamin C locally in response to stress and when ACTH is released from the pituitary leading to high concentrations. There is a significant depletion of adrenal gland ascorbic acid content in young chickens suffering from stress. Freeman, 1967 stated that the bird responds to stress in a way similar to the mammal but the response, as measured by adrenal ascorbic acid depletion, is considerably more rapid in bird.

Lipid Peroxidation/Free Radical Scavenging Activity (MDA Assay)

Pre-slaughter stress can lead to increase of oxidative activity and production of superoxides

free radicals in the muscle of poultry (Shanthaand Decker, 1994). Estimation of superoxide free radicals production in poultry muscle could be a sensitive indicator of pre-slaughter stress related to stunning (Serena et al. 2017). Heat stress elevates malondialdehyde (MDA), an indicator for lipid peroxidation (Altan et al. 2010)

Acid-Base Balance

Birds suffering from heat stress have increased panting or increased respiration rate leading to a reduction in blood partial pressure of CO_2, HCO_3 and an increase in blood pH, resulting in respiratory alkalosis. A significant difference was observed in pCO2 and HCO_3 level in heat stress (Zdenekand Slama, 2011). Acid-base parameters of laying hens are affected by heat stress.

Heterophils: Lymphocytes Ratio

The H: L ratio can be used as an index of stress in chickens. Stress causes a significant shift in the H: L ratio in poultry due to reduced numbers of circulating lymphocytes and higher numbers of heterophils. Maxwell (1993) reported an elevation in H:L ratio during heat and transportation stress.The increase of H:L ratio is a reliable and steady parameter reflecting stress. Corticosterone also influence the H:L ratio. However, in a meta-analysis report by Scanes and Christensen (2014), did not find any shift in H:L between commercial chickens and indigenous broilers suggesting commercial chickens are not stressed.

Hypocalcaemia

According to Marderand Arad (1989), heat stress hampers blood bicarbonate availability for egg shell mineralization, induces increased organic acid availability and decreases free calcium levels in the blood.

Thyroid Profile

Thyroid Hormones (T3 and T4) plays an important role in maintaining the body temperature and metabolic activity. Geraert et al (1996) and Elnagar et al. (2010) reported that triiodothyronine (T3) concentrations consistently decreased in high atmospheric temperature whereas changes in thyroxine (T4) levels are inconsistent with studies reporting decrease (Bobek et al. 1980), increase (Cogburnand Freeman, 1987) and no alteration (Mack et al., 2013).

Immune System and Antibodies

Heat stress causes an immunosuppressing effect on broilers and laying hens.The relative weights of thymus, bursaand spleen has been found to be lowered in laying hens and broilers subjected to heat stress as reported by Ghazi et al. (2012). Bartlett et al. (2003) observed lower levels of total circulating antibodies, as well as lower specific IgM and IgG levels in broilers subjected to heat stress.

Heat Shock Protein (HSP)

To maintain its thermal homeostasis, increased numbers of reactive oxygen species (ROS) are formed leading to oxidative stress with the production and release of heat shock proteins (HSP). High concentrations of HSP70 are found in broilers and laying hens exposed to heat stress (Gu et al. 2012).

Uric Acid

Plasma uric acid (UA) is a major antioxidant and it is an indicator of oxidative stress. A significant increase in plasma uric acid concentration was reported by Huff et al. (2008) in turkeys suffering from transport stress.

Glucose and Non Esterified Fatty Acid (NEFA)

An increase in glucose level for short duration transport occurs due to supply of liver glycogen whereas a decrease in glucose level was observed in three hours transport due to exhaustion of liver glycogen (Zhang et al. 2009). When glycogen reserve is exhausted to make up the shortage of glucose, the birds start utilizing fat and protein leading to the increase in NEFA. NEFA is a good indicator of lipolysis. Nijdam et al. (2005) reported a rise in blood NEFA levels in broilers suffering from transport stress with feed withheld. Stocking density, overcrowding also increases NEFA levels.

However, Geraert et al. (1996) reported that endocrinological changes caused by chronic heat stress in broilers stimulate lipid accumulation through increased de novo lipogenesis, reduced lipolysis, and enhanced amino acid catabolism.

Creatine Kinase (CK)

It is an intracellular enzyme and its elevation is indicative of damage to muscle membrane integrity due to transportation stress (Huff et al. 2008).

Total Protein and Albumin

Total protein and albumin levels increases following different duration of transport in ducklings (Erisir et al. 2008).

Triglyceride

A lowering in plasma triglyceride level were noticed when broilers were transported under high stocking densities due to more energy consumption by the birds (Delezie et al. 2007).

Conclusion

Corticosterone, Adrenal Glands Ascorbic Acid content and MDA levels are the established biochemical indicators for stress. Likewise, HSP, HL ratio, Acid base balance, organ weights of immunological interest are other criteria to assess the stress conditions in poultry. However different findings have been reported by different investigators while assessing these parameters in stress conditions of poultry probably due to different conditions of studies. Therefore, a uniform criteria need to be adopted while assessing these biochemical stress parameters in poultry. Still, these biochemical indicators give some excellent insights into the stress levels of poultry.

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