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Physio-biochemical alterations due to stress in poultry

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Abstract

Stress is inevitable for poultry even in state of the art facilities available in modern poultry industry. Birds have limited body resources for growth, reproduction as well as to cope with different environmental stressors. So, they seem to be particularly sensitive to different stressors including the environmental ones resulting alteration in their behavior and physiological responses. Present manuscript describes the different types of stressors and their effect on physio-biochemical parameters along with physiological mechanism to cope with stress.

Introduction

Stress, a response to adverse stimuli, is difficult to define and understand because of its nebulous perception. The word 'stress' is derived from the latin word 'strengene' which means to draw tight. Stress has been defined by several workers. According to Webster's collegiate dictionary (1981), stress is physical, chemical or emotional factors that cause bodily of mental disturbance and may lead to disease condition finally if not taken care immediately. As per Dobson and Smith (2000), it is the inability of an animal to cope up with its environment, a phenomenon which is often reflected in a failure to achieve genetic potential. Rosales (1994) defined stress as the cumulative detrimental effect of various factors on health and performance of animals. In fact, stress represents the reaction of body to stimuli that disturb normal physiological equilibrium or homeostasis, often with detrimental effects as shown by Khansari et al. (1990). According to Stott (1981), stress is the result of environmental forces continuously acting upon animals which disrupt homeostasis resulting in new adaptations that can be detrimental or advantageous to the animal.

Nonetheless, the most acceptable definition is that "stress is the nonspecific response of the body to any demand", whereas stressor can be defined as "an agent that produces stress at any time". Therefore, stress represents a biological response of body to stimuli that disturb its normal physiological equilibrium or homeostasis.

Generally, stress is used to describe the detrimental effects of variety of stressors on the health and productive performance of poultry. However, it is not always harmful unlike general perception and belief. Birds have limited body resources for growth, reproduction as well as to cope with different environmental stressors (Rosales, 1994). So, poultry seems to be particularly sensitive to different stressors including the environmental ones resulting alteration in their behavior and physiological responses. Further, under the stress conditions, there is redistribution of body resources including energy and protein at the cost of decreased growth, reproduction and health (Beck, 1991). Hence, understanding the physio-biochemical alteration is crucial for devising control measures to combat stress for successful poultry production and welfare.

Types of stress in poultry

Stress is inevitable for poultry even in state of the

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art facilities available in modern poultry industry. The common sources of stress, which can be grouped under, one or more of the following categories (Freeman, 1987).

i. Climatic stress (extreme heat and cold, high humidity)
ii. Environmental stress (bright light, wet litter, poor ventilation)
iii. Nutritional stress (shortages of nutrients, feed intake problems)
iv. Physiological stress (rapid growth, process of maturing sexually)
v. Physical stress (catching, immobilization, injections, transport)
vi. Social stress (overcrowding, poor body weight uniformity)
vii. Psychological stress (fear, harsh care takers)
viii. Pathological stress: Exposure to infectious agents is a common source of stress, however challenges may not result in overt disease. When sub-clinical infections due to poor bio-security and sanitation persist, excessive activation of the immune system will result in a condition known as immunological stress. This condition results in a series of changes in nutrient metabolism induced by mediators of the immune response.

In addition to the categories of stress mentioned above, all the possible types of stressors can be broadly classified under two categories (a) avoidable stressors (b) unavoidable stressors

Avoidable stressors

Overcrowding, poor ventilation, wet litter, toxins in feed, Starvation, high ammonia level, dehydration, poor management etc.

Un-avoidable stressors

Extreme weather, handling, vaccination, transportation, rapid growth, debeaking, lighting medication etc.

It is to be noted that effective stress management involves complete elimination of avoidable stressors and minimizing the load of unavoidable stressors on the birds.

High ambient temperature in the tropics, like that of ours in India accompanied by high relative humidity is one of the most important stressor. Birds are more susceptible to high environmental temperature than low environmental temperature due to absence of sweat glands in the feathered body, fatty nature and high body temperature (40.1 0 C to 41.6 0C). The degree of susceptibility to tropical heat stress is higher in broilers than layers. Among broilers males are more susceptible to heat stress than females (Marin, et.al.2002). Good layers housed in cages are more susceptible than poor layers reared on deep litter.

Common causes of stress in poultry

Some of the most common causes of stress in poultry as categorized by Rosales (1994) are summarized as follows:

a. Poor brooding conditions (low temperatures, cold water)
b. Contaminated premises (built-up litter, early exposure to various disease agents)
c. High stocking density (limited feeder and dringker space)
d. Temperature exteremes (cold and heat)
e. Handling, weighing, vaccination, grading and transport (pain, physical damage)
f. Beak trimming (handing pain)
g. Lack of body weight uniformity (magnified differences in the packing order)
h. Rapid growth (Strict nutrient demand)
i. Quantitative feed and water restrictions (frustration, hunger)
j. Postvaccinal reactions (reduced feed intake, fever)
k. Feed quality problems (variation in nutrient content)
l. Long or uneven feed distribution (split feeding)
m. Sex separate feeding (pressure to restrict body weight gains)
n. Harsh caretakers (poor husbandry)
o. Inadequate ventilation (deterioration of the air quality)
p. Clinical or subclinical diseases (reduced feed intake, fever, pain)
q. Poor litter conditions (wet and cold)
r. Sexual maturity and onset of egg production (drastic stimulation with feed and light)

Physio-biochemical alteration due to stress in poultry

Several workers have reviewed the effect of stressors in fowl (Brown 1967, Freeman, 1971). They recoded the following physio-biochemical alteration in poultry:

i. Atrophy of the thymus and atrophy of the bursa of fabrics in young birds,
ii. Enlargements of the anterior pituitary and the adrenal glands.
iii. Depletion of the adrenal cholesterol.
iv. A rise level of plasma corticosterone, insulin or glucagon.
v. Increased reliance on glucose as an energy source.
vi. Hypoglycemia (increased glucose utilization).
vii. Decreased growth and increased muscle degradation.
viii. Release of acute-phase cytokines (monokynes and lymphokynes)
ix. Impaired growth of cartilage and bone.
x. Synthesis of specific heat shock proteins.
xi. Decreased voluntary feed intake (anorexia)
xii. Increased body temperature
xiii. Changes in the level of plasma metabolites (e.g. glucose, tryglyceride, non-estrified fatty acids and lactate). Epinephrine content in yolk of donor hens also serves as a very good tool to reflect stress load in layer stock.
xiv. Changes in the numbers of circulating leucocytes profiles (heterophil: lymphocyte ratios and basophil and eosinophil numbers).
xv. Immunosuppression
xvi. Excess fat deposition in the abdomen (abdominal fat pad).
xvii. Ascites (water belly) in high producing broilers.

Physiological mechanism of stress regulation in poultry

Exposure of birds to stress is an inevitable event in poultry husbandry, when the threshold level of stress is crossed it results in distress to birds. Then the birds show stress syndromes, which are classified into three stages.

1. Stage of alarm reaction (Neurogenic system).
2. Stage of resistance or adaptation (Endocrine system).
3. Stage of exhaustion.

Neurogenic (sympatho- adrenal) system (Short-term regulation of stress)

This system consists of sympathetic (post ganglionic) nervous system and adrenal medullary tissue. It controls the rapid response of the birds i.e. fight or flight or alarm (emergency) reaction. This reaction lasts only a short time. It is characterized by increased rates secretion of the catecholamine from the adrenal medulla. These catecholamines prepare the bird for "Fight or Flight" reaction and commanding a rapid release of glucose in blood, depletion of liver glycogen, increased peripheral vasomotor activity, altered ventilation rate and increased neural sensitivity (Siegel. 1980). Catecholamines also stimulate the activity of hepatic adenyl cyclase, the enzyme required for the production of cAMP (Robinson and Sutherland, 1971). cAMP regulates the number of energy reaction (physiological processes) and directly increases the formation of antibody (Braun et al. 1971).

Endrocrine system (Long-term regulation of stress)

Involvement of endocrine system in stress regulation is called the 'stage of resistance'. This system is comprised of hypothalamus-pituitary adrenal axis (HPA). It is characterized by adrenal cortical hypertrophy and increased synthesis and release of adrenal glucocorticoids, known as corticosterone in bird (Siegel, 1980). Activation of the HPA is a longer-term adjustment by the animal to the surrounding changes. Selye (1936) called it General Adaptation Syndrome (GAS).

The endocrine mechanism of stress regulation is started with the stimulation of hypothalamus and release of ACTH from anterior pituitary, which causes the increase of adrenal cortical steroid secretions. Continuous stimulation to adrenal cortex leads to chronically high levels of corticosteroid hormone. This hormone is responsible for the formation of glucose from body's reserve of carbohydrates, lipid and proteins. Corticosteroids contribute to many of the disease associated with long-term stress, such as, cardiovascular and gastronistestinal disease, hypercholesteraemla, metabolic rearrangements and antibody suppression. (Siegel, 1985).

Other hormones

i) Glucagon: The á cells of the pancreas are the source of glucagon, are stimulated in alarm response in both mammals and birds (Freeman. 1980).
ii) Thyroid hormone: Hormone produced by thyroid glands are also involved in stress regulation (Siegel, 1980).

Stage of exhaustion

Finally, if the bird does not recover from the stressor

and the availability of body reserves and hormones from the adrenal gland are inadequate, a third or exhaustion phase leads to fatigue of the homeostatic mechanisms and death (Maxwell,1993).

Future course of stress managemental practices in poultry

Research work in the area of stress physiology should be directed in future in the following directions.

Need good indicator of physiological stress

The physiological indicator of stress such as atrophy of the thymus and bursa of fabrics in young birds, enlargements of the anterior pituitary and the adrenal glands are good indicator of stress but there are inherent problems with their detections. These organs cannot be weighed in live birds and require slaughter of the animal. Therefore, a suitable technique of physiological indicator of stress is currently needed.

Suitability of the technique

Suitability of technique is also an important factor, particularly for blood sampling of bird for hormone estimation. Practical problems can be associated with techniques themselves.

Mechanism of stress

To study the mechanism of stress (climatic and environmental stress) laboratories should be strengthen with some specific facilities like climatic chamber.

Identification of a physiological cue

initiating the vicious cycle of events in birds that are under stress.

Amelioration of stress in birds at physiological level

Development of a anti-stress kit for birds.

Suitable managemental practices

The production efficiency of poultry is severely affected by various kind of stressors. It has significant effect on economic production of poultry. Appropriate managemental practices can be investigated to reduce the different type of stress in poultry and getting the best returns from them. The research work should begin right from construction of poultry shed, along with feeding, disease control and other managemental options.

Conclusion

The goal of poultry scientist should be to strike a balance between the hypo-and hyper-stress and to find as much eustress as possible and to minimize distress. While devising strategies for stress control, it is necessary to eliminate all avoidable forms of stressors and maintaining unavoidable stressors under control. Thus, the ultimate aim of successful poultry husbandry is not eliminate stress but to maintain it at optimum level for good production efficiency. A targeted multi-disciplinary futuristic approach is advocated so that the problem of stress is well tackled.

Multifarious efforts should be made to develop suitable technology to overcome the problem of follicular atresia as this is one of the main channels responsible for the drop in egg production under stressful conditions.

References

1. Freeman BM. World's Poult. Sci. J., 1987; 43: 15.
2. Marin RH, Benavi Dex E, Gorica DA and Satterlee DG. Poult. Sci. 2002; 81: 261-64.
3. Maxwell, M.H. World's Poultry Sci. J. 1993; 49:34-43.
4. Siegel H.S. Bio-Sci., 1980; 30: 529.
5. Freeman BM. Research in Vet. Sci., 1980; 28: 389.
6. Freeman BM. World's Poult. Sci. J. 1971; 27: 263.
7. Braun W, Massaki I, Winchurch R and Webb D. Annals New York Academy of Science. 1971; 115: 417.
8. Beck JR. Zootechinica International. 1991; XIV(3): 30.
9. Dobson H, Smith RF. What is stress and how does it affect reproduction?Anim Reprod Sci. 2000; 60: 743-752.
10. Rosales AG. Stress syndrome in birds. Journal of Applied Poultry Research. 1994; 3: 199-203.
11. Khansari DN, Murgo AJ, Faith RE. Effect of stress on the immune system. Immunol Today. 1990; 11: 170-175.
12. Stott GH. What is animal stress and how is it measured. J Anim Sci. 1981; 52: 150-153.
13. Robinson G.A. and Sutherland E.W. New York Academy Sc. 1971; 185: 5.
14. Siegel H.S. Bio-Sci. 1980; 30: 529.
15. Selye H. Nature. 1936; 7: 32.
16. Siegel P.B. World's Poult. Sci. J. 1985; 41: 36.
17. Brown Kl. Environmental control in poultry production. 1987; 101-113, Edit, Carter, T.C. and Oliver & Boyd, Edinburg.