SUMMER STRESS IN POULTRY: ITS EFFECT ON PRODUCTION AND MANAGEMENTAL PRACTICES TO AMELIORATE

Harshini Alapati, Jaishankar N and Shivakumar M. C.

Stress is any kind of deviation from the normal physiological homeostasis of the body. The term stress is used to describe the various factors that affect the health and performance of the birds. Animals or birds reacts to cope the stress conditions, by redistributing body resources including the dietary nutrients to withstand the stimuli at the cost of decreased growth, production and health. Long term exposure of birds to stress conditions leads to starvation and fatigue, furthermore increases susceptibility to pathogens, reduced immunity and results in death.

Stressors

Any stimulus that evokes the stress response is called "Stressor". These stressors can be broadly categorized into *viz.,*

Biotic i.e., virus, bacteria, fungi or parasites and

Abiotic factors such as temperature, solar radiation, humidity, overcrowding, poor ventilation, harsh handling, catching, immobilization, bright light, transport during hot hours, shortage of nutrients, toxins in feed, higher plane of nutrition for rapid growth etc.

Why Summer stress is a major concern???

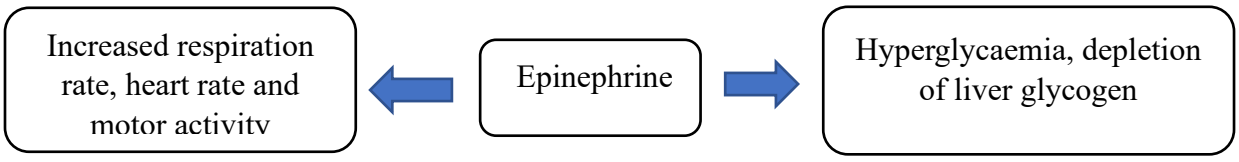
High ambient temperature in the tropics, like that of ours in India accompanied by higher relative humidity resulting Heat stress is one of the most inevitable stressors in poultry production.

- Birds are more susceptible to high environmental temperature than low environmental temperature due to absence of sweat glands, feathered body, fatty nature and high body temperature (40.1 to 41.6°C / 105 to 106.4°F).
- The degree of susceptibility to tropical heat stress is higher in broilers than layers attributed to their rapid growth and higher metabolism.
- Among broilers males are more susceptible to heat stress than females with respect to their body size.
- Good layers (commercial lines) housed in cages are more susceptible than poor layers (developed varieties of native chicken ex: Swarnadhara, Vanaraja) reared on deep litter system of housing.
- Most of the commercial layer and broiler houses in the Indian scenario are open sided, i.e., only 1 to 1.5 feet of side wall is constructed with, rest is made of wire mesh. Exposure to direct hot drafts of wind is inevitable during peak summer months.

What happens to birds during heat stress!!!!!

Physiological mechanism of the body in response to the heat stress is similar any type of the bird, exception to duration and intensity of stressor. When the intensity of stress exceeds threshold level, birds exhibit stress syndrome, which is manifested in three stages

1) Stage of alarm or neurogenic reaction – it is the initial response of the body mediated by sympathoadrenal axis immediately after the identification of stressful stimuli. This reaction operates for short term regulation of stress or disturbance by the nervous



Veterinary College, Hassan, KVAFSU, Bidar, Karnataka, India
harshinialapati31042@gmail.com

system and stimulates the sympathetic post ganglionic fibres to release the epinephrine from adrenal medulla.

2) stage of adaption or resistance (endocrine) – if the stimulus persists for the longer duration, endocrine system reacts through activation of Hypothalamic-pituitary-adrenal axis (HPA).

Hypothalamus

↓ *Corticotrophin releasing hormone*

Pituitary gland

↓ *Adrenocorticotrophic hormone*

Adrenal cortex

↓

Corticosterone → Delays proliferation of intestinal epithelial cells → Decreased villus height & crypt depth → damages intestinal mucosa → pro-inflammatory agents alter the tight junctions of intestinal epithelium → increases the permeability of pathogens

↓

- Breakdown of muscle and gluconeogenesis→ raises blood glucose.
- Electrolyte imbalances → increased blood volume & pressure.
- Panting → Respiratory alkalosis → reduced pH, HCo_3^{2-} -→ Impairs shell calcification.
- Reduced levels of FSH & LH → decreases Estradiol concentration→ impairs follicular size & yolk quality and fertility.
- Suppression of immune system.

3) stage of exhaustion – when the body couldn't restore the normal physiological process as the reserves falls deficit.

Indicators of Heat stress

- Increased body temperature
- Decreased voluntary feed intake (anorexia).
- A rise in the level of plasma corticosterone, insulin or glucagon.
- Decreased growth and increased muscle degradation.
- Release of acute-phase cytokines (monokines and lymphokines).
- Impaired growth of cartilage and bone.
- Synthesis of specific heat shock proteins.
- Increased heterophil: lymphocyte ratios (i.e., changes in the numbers of circulating leucocytes profiles).
- Atrophy of the thymus and bursa of fabrics in young birds → Immunosuppression
- Excessive fat deposition in the abdomen (abdominal fat pad).
- Ascites (water belly) in high producing broilers.

Table 1: Environmental Temperature and signs in the domestic poultry

55°F – 75°F	Thermoneutral zone
65°F – 75°F	Ideal temperature zone
75°F – 85°F	A slight reduction in feed consumption
85°F – 90°F	Feed consumption falls further, cooling should be started before this temp is reached.
90°F - 95°F	Feed consumption continues to drop, danger of heat prostration among layers, cooling strategies should be taken
95°F-100°F	Heat prostration, water consumption is high.
>100°F	Emergency measures must be taken, survival is concern at these temperatures.

How to ameliorate the heat stress???

Environmental strategies - Intermittent Photoschedule (light).

Housing management - Sites election, design and construction, ventilation, internal and roof cooling, Density of birds.

Nutritional strategies- Increasing energy density, Amino acid balance, Vitamins – A, C, E, minerals, non-nutrient feed additives, Water and electrolyte balance.

Feeding strategies - Early feeding, Intermittent feeding, Sex separate feeding, Fasting or feed with drawl, changing the physical form of feed.

Genetic strategies -Selection for heat tolerance, Selection for disease resistance, Use of major genes – Naked neck (*Na*), Frizzle(*F*), Dwarf(*dw*), Silky (*h*), Slow feathering (*K*).

Early heat conditioning or epigenetic programming.

1. Environment Strategies

Intermittent Photo Schedule

An intermittent light regime can improve the feed efficiency and thus the broiler production efficiency, by decreasing the fat deposition associated with increased incidence of leg abnormalities, metabolic and cardiovascular diseases, ascites. The favourable effect is related to the lower heat production during both light and dark period.

This photo schedule contains more than one scotophase and one dark phase which recur at 24 hr intervals. This regime increases the feed consumption during cooler part of the day.

Symmetric - when scotophase and dark phase are of equal length.

Asymmetric - when they are not in equal length.

- broiler raised under 2L:4D & 1L:3D intermittent light regime showed significant improvement in the tolerance level of heat stress.
- The initial reduction in body weight gain of birds under intermittent schedule is followed by compensatory growth, but the compensatory growth depends on genotype and sex.
- Physical activity in broilers were lowest under 100Hz fluorescent light and highest under incandescent.

2. Housing Management

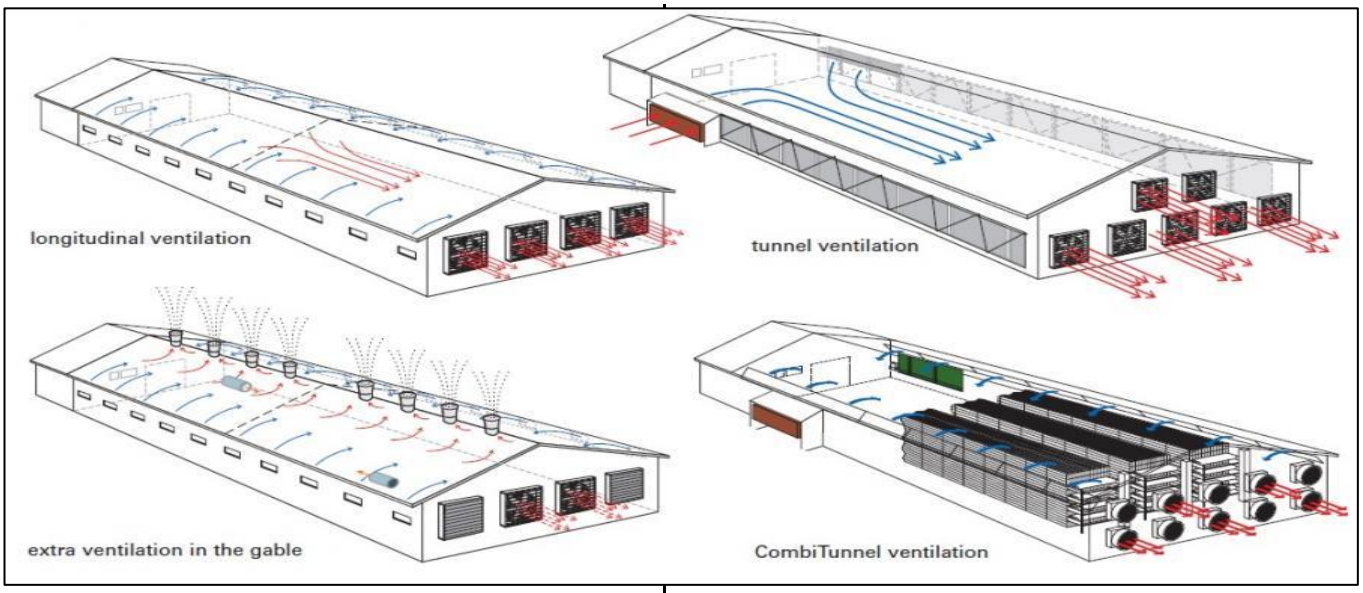
- Orientation: east west to reduce direct solar radiation
- Shade of trees and green crops around the houses will prevent direct heating, vegetation should be mowed frequently so that it does not obstruct air flow
- Houses should be oriented perpendicular to wind direction for maximum air movement.
- Recommended spacing between two sheds D=0.4×H×L(0.5) [H & L height and length in feet.]
- Width of building should not exceed 12 meter.
- Gable roof is ideal for the tropical climates for effective ventilation (for removal of hot expired air).
- Insulating materials like sawdust and straw can be used to reduce influx of heat into the building.
- Good reflective roof coating on the exterior of the roof to reduce roof temperatures
- The outside walls and roof should be painted white or any reflecting paint i.e., metallic zinc or aluminium.
- Roof should be clean and dust free to improve the reflectivity of solar radiation.
- In open sided houses wet curtains or gunny bags may be hanged over the wire mesh.
- Drawing air through adsorbent, porous cooling pads and fan system, vertical ceiling fans at 3-7 m above the birds and 7.6-15m apart depending on size and air velocity.
- In house fogging, sprinkling over roof.
- Cross ventilation or tunnel ventilation system for effective exchange gases and expired air
- Full monitor type of roofing is the best for the tropical climates as it provides vertical ventilation.
- Reduction of housing density to 30% enhances the ventilation rate

Covering the side walls with curtains during the peak temperatures of the day

Foggers inside the shed.

Sprinklers on the outside of roof.

Types of Ventilation to improve wind flow in environmentally controlled houses



3. Nutritional Strategies

Increasing Energy Density

ME requirements of birds decreases with increasing temperature due to reduction in energy requirements, resulting in growth depression. Increasing the energy density can partially overcome the growth depression. Higher fat content reduces heat production since fat has lower heat increment than protein and carbohydrate.

Dietary Protein and Amino Acid Balance

- The protein requirement is decreased because of the suppression in production performance.
- It has been shown that both protein synthesis and breakdown are affected by chronic heat stress, and protein synthesis is more affected than breakdown, leading to reduced protein deposition.
- The decreased protein synthesis cannot be restored by high dietary protein level. Moreover, a high protein diet even leads to higher metabolic heat production resulting in depressed growth.
- Special balancing of arginine, leucine, Sulphur containing amino acids is essential.
- Lysine deficiency increases the body temperature.

Vitamins

- The detrimental effect of heat stress on egg production can also be alleviated by dietary supplementation of Vitamin A (8000 IU/kg diet). It improves the immune status of heat-stressed laying hens.
- Supplementation of cholecalciferol, Vitamin E, K .
- 200 mg vitamin C and 200 mg Vitamin E per kg of feed, improves the antioxidant defence of the

heat stressed chickens against free radical damage .

Minerals

- Marginal phosphorus levels, when combined with heat stress, can lead to increased mortality rates, particularly among older birds.
- Dietary supplementation of chromium (120 ppb) is favourable during heat stress as it increases feed intake and body weight, improving feed efficiency and carcass characteristics.
- Zinc (4.5 mg/kg) supplementation resulted in an improved live weight gain, feed efficiency, and carcass quality traits

6. Non nutrient feed additives

Heat stress alters the diversity and abundance of gastrointestinal microbiota. Supplementation of probiotics in feed such as *Lactobacillus spp, Bifidobacterium spp* strains may enrich the diversity of flora in chicken jejunum and caecum, and therefore restoring the microbial balance and maintaining the natural stability of jejunal and caecal microbiota of broiler chicken exposed to heat stress.

Water and electrolytes

The suppression of growth in broilers can be partially alleviated by supplementation of 1% NH_4Cl or 0.5% $NaHCO_3$ and 1.5 to 2.0% K in the form of KCl. Supplementation of $NaHCO_3$ @ 4 -10 Kg per tonne in layers helps in the mineralization of shell and restores the defects of caused due to heat stress

Table 2: Water requirements of chicken

Type of bird	Season	Water: Feed intake
Growing	Summer	2- 2.5
Growing	Winter	1.5 – 2
Layer	Summer	2.6 – 3.5
Layer	Winter	1.8 – 2.2

4. Feeding Strategies

- Temporary feed restriction before heat exposure is an effective way to enhance thermal resistance of broilers.
- Feed withdrawal reduces heat production, increment speed of body temperature and mortality of broilers.
- The dual feeding programme is another strategy used for broilers, which includes a protein diet during the cooler phase and an energy-rich diet during the warmer phase of each day and maintains a nutritional balance by adequate proportion of the two diets.
- During heat challenge, dual feeding reduces the body temperature and mortality.
- Partial feed restriction of broilers during day 4 to 6 was experimentally proven to improve growth rate and thermal resistance to heat stress during marketing age (35-42d).
- Feeding schedule for laying hens should comprise $1/3^{rd}$ ration early in the morning and $2/3^{rd}$ after the peak temperatures or evening.
- Some experiments shown that night time feeding improved the egg shell quality of heat stressed laying hens.
- Wet feeding increases the dry matter (DM) intake and, therefore, alleviates partially the effect of heat stress on feed intake and laying performance. Feeding a wet diet containing 50% moisture increased the DM intake of layers at high temperature.
- Normally the layer diet is provided in mash form. During summer, although the feed consumption is not affected by pelleting the ration, egg production, feed efficiency and water intake were significantly increased in laying hens.

5. Genetic Strategies

In poultry, there are several traits that favour heat tolerance. Feather features can be controlled by selection and breeding plans with the use of dominant genes such as naked neck (Na) or frizzle (F) genes. Tropical relevant genes in local fowl

Naked neck gene: presence of this gene decreases the feather covering by 20% and 40% (relative to body weight) in the heterozygous (*Na*/*na*) &homozygous (*Na*/ *Na*) birds respectively. The beneficial effect of Na genotype is more pronounced in broiler chickens with high growth rate and breast meat yield Ex: HIT CARI developed by Central Avian Research Institute.

Frizzle gene: Frizzle (*F*) gene may reduce the heat insulation of feather by curling the feathers and reducing their size. Effect of heat tolerance is lesser than that of Naked neck gene. However, there is an additive effect in the heterozygous gene utilization (Na/na F/f) in broiler chickens Ex: Caribro Tropicana, Cari Bro Mrutyunjay

Selection For Heat Tolerance

- WLH shown to have greater tolerance than heavier breeds like RIR, barred PR, white PR and Austarlop.
- Use of temperature-controlled chambers for short periods (37^{0}C & 60% RH)
- Survivors were reproduced after recovery phase of 60 days, survivability rate improved from 16% to 69% in 7 generations.
- Superior egg production was noticed in thermotolerant birds.

7. Early Heat Conditioning / Epigenetic Programming

Epigenome is the protein covering that constitutes histone proteins around the DNA, epigenome regulates the expression of the genes and plays a crucial role in the early prenatal period in the determination of up or down regulation of gene expression related to environmental stressors. exploitation of epigenetics is useful for the development of thermotolerant strains of chicken.

Table 3: List of genes that affect the thermotolerance in chicken

Gene	Nature of inheritance	Direct effect	Side effect
Dwarf (*dw*)	Sex linked recessive multiple allelic	Reduction in body size up to 10 - 30%. Mostly utilized in broiler breeding.	Reduced metabolism improved fitness, disease tolerance.
Naked neck (*Na*)	Incomplete dominant	Loss of neck feathers, reduction in secondary feathers	Improved ability for convection and adult fitness
Frizzle (*F*)	Incomplete dominant	Curling of feathers	Improved ability for heat tolerance
Silky (*h*)	Recessive	Long barbs at the contour feathers	Improved ability for convection
Slow feathering (*K*)	Dominant sex linked multiple	Delay in feathering	Increased heat loss, reduced adult mortality

Early heat conditioning in broilers chicks by exposing to 36º C for 24 hours during 3 to 5 days of age, improved the heat tolerance and growth efficiency, reduced mortality rate in later stages of life (35d). compared to the control group. Increasing the temperature during embryonic growth i.e., E07 to E17 improved the thermotolerance, egg production and lowered plasma corticosterone levels in laying hens.

Conclusions

"Effective stress management involves complete elimination of avoidable stressors and minimizing the load of unavoidable stressors on the birds." Protection of bird's welfare, minimizing of production losses and

mortality cannot be achieved by adapting one or two managemental practices. Cascade of housing & environmental strategies, balanced dietary nutrients, special feeding schedule during summer months and improvement of genetic potential of birds through selection and utilization of Naked neck and frizzle will benefit the poultry farmers.

* * * * * * *