Benefits of phytogenics for laying hens during environmental challenges

Due to global climate changes, climatic variations have altered the environmental temperatures, precipitation patterns, and atmospheric carbon dioxide in the last few decades. Climatic conditions have an impact on poultry farming and so controlling environmental temperature during hot seasons is one of the significant challenging factors in egg poultry production today.

by Mojca Osredkar Mergole, DVM MSc, Global Technical Manager Poultry and Roberto Montanhini Neto, DVM MSc PhD, Global Unit Lead Monogastrics, Delacon, Cargill.
www.delacon.com

Environmental stress influences a wide range of factors that can lead to increased colonisation of birds by pathogens, faecal shedding, and horizontal transmission. High environment temperatures affect the performance parameters and require various physiological and immunological adaptations of birds. Laying hens are particularly vulnerable to heat stress because they must support a long production cycle.

It has been well-documented that dietary inclusion of phytogenic extracts could improve poultry performance by increasing digestive enzyme secretion, lowering the number of harmful bacteria in the digestive tract, modulating intestinal morphology functions, and positively affecting productivity, blood metabolites, and immunological and antioxidant status of birds.

Elevated environmental temperatures are associated with reduced feed intake and egg production. The response of birds to elevated environmental temperatures is to reduce feed intake, limiting the heat produced from digestion. This reduced feed intake will ultimately reduce egg production in laying hens due to insufficient energy and nutrient intake.

Environmental stress causing depressed feed intake alters the hypothalamic-pituitary axis and orthosympathic nervous system functions.

This results in modified thyroid hormonal activity in metabolism necessary for skeletal development, growth, and body temperature regulation. It helps laying hens adapt their body's temperature to cope with hot temperatures.

The most efficient temperatures for laying hens are between 20°C and 24°C. When temperatures rise above 24°C, shell quality, and egg weight will reduce. The elevated blood pH at higher temperatures (alkalosis due to higher respiration rate) can cause the bioavailable form of ionised blood calcium to bind to proteins.

It makes it unavailable in the shell gland to form the eggshell. When the temperature elevates from 30°C to 38°C, the laying hens will produce eggs with thin eggshells due to increased blood pH and decreased calcium and bicarbonate in the blood.

Environmental stress suppresses laying efficiency by reducing the size of reproductive organs (follicular and oocyte development). Hot climatic conditions delay the process of ovulation by reducing follicular size.

According to several studies, climate stress could reflect a reduction in feed conversion by up to 31.6%, a drop in egg production from 28.8% to 36.4%, and a 3.41% weight loss of the egg-laying hens. In addition, periods of high temperatures have been shown to cause a significant reduction of the weight of the eggs by 3.24%, a reduction in eggshell thickness by 1.2%, and eggshell weight by up to 9.93%.

Table 1. Effect of dietary PFA on the laying performance under challenging environmental conditions.

Parameters	Control	Biostrong Comfort
Laying rate (%)	90.3	92
Egg weight (g)	62.8	63.3
Daily egg mass (g/hen)	58.2	59.8
Mortality (%)	18.7	8.0

Food safety issues caused by environmental stress

Today poultry farming needs to face the issue of food safety as a significant part of the modern food quality concept, also concerning environmental stressful conditions. Several scientific studies have

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investigated how climate stress affects food safety via several possible mechanisms.

Climatic stress could induce loss of intestinal barrier integrity, disruption of the immune response, and perturbation of the intestinal microbiota to increase the potential for harmful bacteria to colonise the intestinal tract and invade the host.

Such colonisation will increase the risk of carcass contamination during the processing of retail poultry products. It will also increase the potential for harmful bacteria (for example salmonella) to translocate to the reproductive tract, contaminating eggs during formation.

Exposure to high environmental temperatures increases the reactive oxidative species (ROS) in layer birds and reduces the yolk quality by inducing lipid peroxidation of cell membranes. The yolk maturation rate may be reduced due to the fatty acid composition, heat shock proteins, and antioxidant level deviation.

How could environmental stress be mitigated?

Possible mechanisms behind improved nutrient digestibility by PFA (Phytogenic Feed Additives) supplementation could be attributed to the ability to stimulate appetite, saliva secretion, intestinal mucus production, bile acid secretion, and activity of digestive enzymes such as trypsin and amylase. PFA could improve uterine health and increase calcium storage and pancreatic secretions, resulting in the enhancement of nutrient digestion and, consequently, the improvement in eggshell and egg quality.

Phytogenics compounds

Phytogenic compounds, such as flavonoids, have been shown to exert a beneficial effect on gut morphology, their ability to modulate barrier permeability by up-regulation of claudin-7 expression to protect from damage of endotoxins by maintaining the integrity of tight junctions.

They preserve the mucus layer by promoting mucin production, regulating the intestinal immune system with differentiation and proliferation of immune cells, and increasing IgA secretion.

With a favourable modulation of microbiota profiles and homeostasis via regulation of microbiome and metabolome, phytogenic compounds can help remodel systemic metabolism (glucose metabolism and lipid metabolism).

Citrus flavonoids can reshape the homeostasis of bile acids via up-regulation of the liver-gut axis and have been shown to counteract dysbiosis and help to recover intestinal permeability. Flavonoids, like naringenin, modulate intestinal immunity and further improve local and systemic inflammatory conditions.

Antioxidant properties of polyphenols

Studies have indicated that the antioxidant properties of polyphenols helped to alleviate the adverse effects of environmental stress by reducing the production of ROS, leading to the reduction of oxidative stress. Polyphenols are external antioxidants that serve as the first defence for cells against excessive free radical production and protect their constituents from oxidative damage.

With their lower redox potentials, polyphenols can thermodynamically reduce highly oxidising free radicals because of their capacity to chelate metal ions and free radicals. Mechanisms include the activation of antioxidant enzymes (for example, SOD – superoxide dismutase, GPH-Px – glutathione peroxidase), inhibition of pro-oxidant enzymes such as xanthine oxidase, direct scavenging of ROS by donating electrons, and an increase in the antioxidant activity of antioxidant substances.

Flavonoids can inhibit oxidative damage through direct free radicals scavenging and indirect antioxidant action based on Nrf2/HO-1 pathway to fight against oxidative stress. Flavonoids like naringenin and naringin are the most effective at eliminating free radicals since they must scavenge solid activity for lipid peroxidation inhibitors and can enhance the function of the small intestine in nutritional absorption.

Curcumin increased the activity of antioxidant enzymes, reduced serum corticosterone levels, inflammatory cytokines response, and liver enzymatic activity, which enhanced the immunity of laying hens under hot climatic conditions.

Dietary flavonoids can modulate the biomarkers of thermal stress, including LDH, CK, and HSP70, to alleviate climate stress.

Resveratrol reduced the elevated temperature stress-generated overexpression of HSP27, HSP70, and HSP90 mRNA in the spleen and bursa of Fabritius and expression of Nrf2 in Japanese quails.

Rosemary extract could alleviate heat stress by inducing HSP70 expression before stress occurs and when birds are under acute pressure.

Protective effects of PFA on the performance of laying hens

A field evaluation of Biostrong Comfort (PFA as a natural combination with flavonoids, Delacon Biotechnik GmbH, Austria) protective effect against possible impacts of climate stress in laying hens from 20 until 41 weeks of age during high ambient temperatures in the summer season was made in Bastos, Brazil.

The performance of 29,295 birds in the control house with no additive in feed was compared to 15,630 birds in the test house with the addition of Biostrong Comfort (250g/MT) in feed.

The evaluation was made between October 2021 and February 2022 when outside daily temperatures were over 35°C for several days, according to INMET (Instituto Nacional de Meteorologia).

In this period, the laying rate of layers in the test house was 92% compared to the 90.3% laying rate in the control house.

The quality of egg weight was numerically improved by adding PFA in feed respectively (63.6g vs. 62.8g). Daily egg mass was numerically higher (59.8g/hen) in the test house compared to the control house (58.2g/hen).

Conclusion

PFA, when used as nutritional additives, may potentially act in support of modulating growth, hormonal, and enzyme responses in laying hens.

PFAs have been shown to have the potential functionality to eliminate reactive oxygen species, which may lead to lower lipid peroxidation and improved performance, indicating that PFAs may be helpful nutritional agents for ameliorating environmental challenges.

In the presented trial, Biostrong Comfort has been shown to increase the laying rate and improve performance during natural climate stress in layers. ■

References are available from the author on request