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Strategies to Improve Egg Quality through Environmental Control and Nutrition

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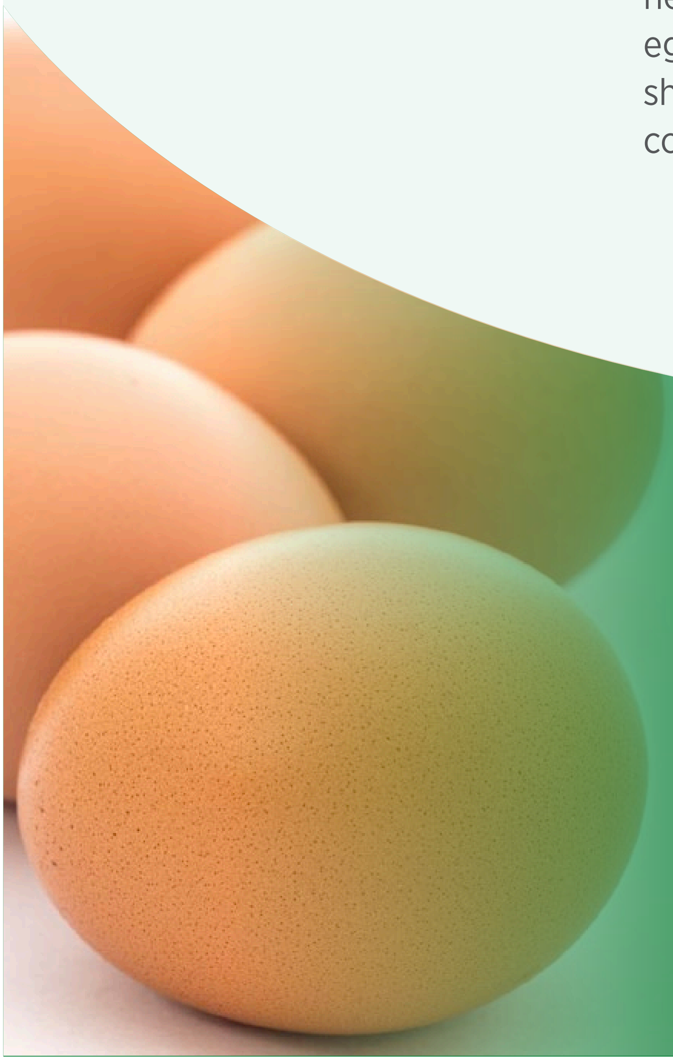
INTRODUCTION

Egg production is one of the pillars of the global poultry industry. Beyond production volume, egg quality has become a key factor to ensure consumer acceptance, production system efficiency, and producer profitability

Egg quality depends on numerous factors, including proper nutrition and a controlled environmental setting.

Both are closely related to the hen's health and her ability to produce eggs with a strong shell, proper shape, and adequate internal composition.



This article reviews the most effective nutritional and environmental strategies to improve egg quality.

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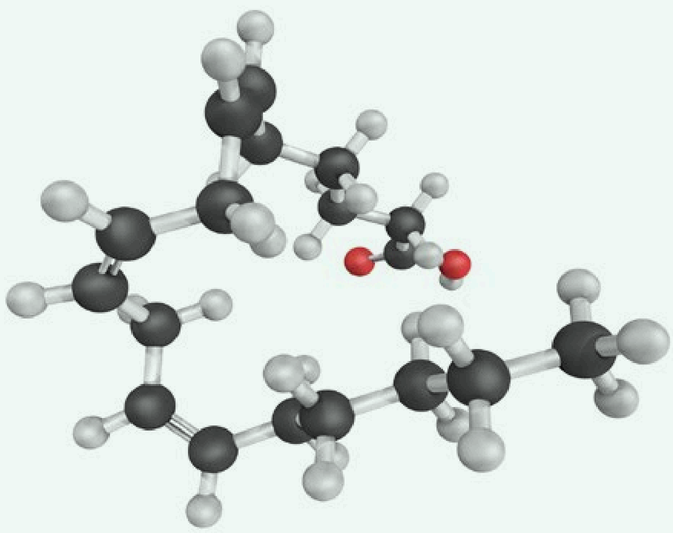
NUTRITION: THE BASIS FOR EGG QUALITY

Protein and Essential Amino Acids

Laying hens require optimal levels of crude protein and essential amino acids to maintain consistent egg production and ensure quality.

Amino acids such as methionine and lysine are critical for egg content formation and for maintaining the bird's overall metabolism.

According to Harms and Russell (2001), protein deficiencies can directly affect egg weight, composition, and albumen quality. Additionally, linoleic acid, an essential fatty acid, has shown a positive influence on egg weight and shell quality (Leeson & Summers, 2005).



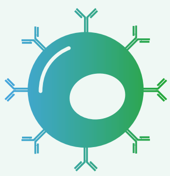
Calcium, Phosphorus, and Vitamin D

Calcium is an essential component for eggshell formation. Birds require a continuous supply of available calcium, especially during nighttime, when shell formation occurs.

For efficient absorption, vitamin D3 is needed, as it supports calcium transport to relevant tissues and organs (Nys et al., 2011).

Vitamin D, also known as the “sunshine vitamin,” is a fat-soluble vitamin essential not only in the context of calcium and phosphorus metabolism but also for other biological functions.

It enables **proper calcium and phosphorus absorption** and retention—key minerals for the formation of bones, teeth, muscles, and the eggshell.



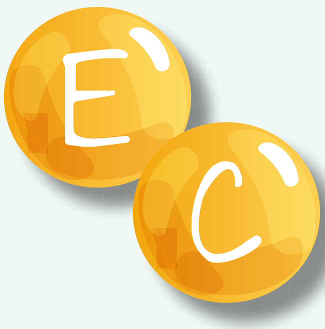
Beyond the skeletal system, vitamin D plays a critical role in **reducing inflammation, preventing infections, and strengthening the immune system.**

It also participates in **controlling the growth of abnormal cells,** such as cancer cells, and has direct effects on **neuromuscular and immune functions,** promoting the overall health of laying hens.

Phosphorus works together with calcium for skeletal development and shell integrity. An imbalance between the two can lead to fragile shells, an increase in broken eggs, and a reduced productive lifespan of the layer.

Microminerals and Antioxidants

Minerals such as zinc, manganese, and copper play key roles in enzyme formation related to calcium metabolism and shell strength. Including these minerals in organic (chelated) form has shown greater bioavailability and better utilization by the bird (Pimentel et al., 2011).



Antioxidants such as vitamin E and vitamin C help reduce oxidative stress, which can affect internal egg quality. They also contribute to better immune responses under challenging environmental conditions.

ENVIRONMENTAL CONTROL: A KEY CONDITION FOR WELFARE AND PRODUCTION

Temperature and Ventilation

Ambient temperature has a direct impact on the hen's physiology.

Temperatures above 28°C induce heat stress, leading to reduced feed intake, altered acid–base balance, decreased calcium absorption, and consequently, deterioration of eggshell quality (Star et al., 2008).

Proper ventilation and cooling systems help maintain comfortable barn temperatures, reducing heat stress and promoting bird welfare. These systems are also useful for controlling harmful gases such as ammonia.

Relative Humidity and Air Quality

High relative humidity (above 75%) can compromise litter quality, increasing the incidence of pododermatitis and respiratory problems. Excessive humidity combined with high temperatures creates an environment conducive to bacterial growth, which can affect flock health and egg safety (De Reu et al., 2008).

Air renewal, proper filtration, and constant monitoring of CO_2 and ammonia are essential strategies for maintaining a hygienic and breathable environment within facilities.

Lighting

Light management directly affects the reproductive behavior of laying hens. Poorly designed lighting programs can cause stress and alter ovulation.

It is recommended to provide 14 to 16 hours of light per day during the laying phase, with intensities and frequencies that simulate natural conditions (Lewis & Morris, 2006).

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MANAGEMENT AND COMPLEMENTARY STRATEGIES

Feeding Programs

A feeding program adapted to the different production phases allows adjustments in energy, protein, and mineral requirements, preventing deficiencies or excesses that may impact egg quality. Additionally, additives such as prebiotics, probiotics, or enzymes can be used to improve nutrient digestibility.

Strategies for Heat Stress

During hot periods, it is recommended to:

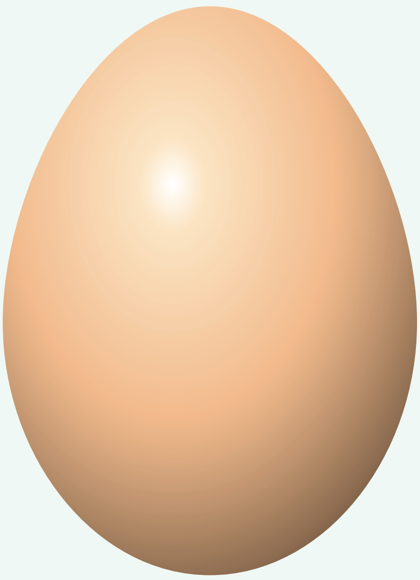
- Provide fresh, abundant water.
- Offer feed during cooler hours of the day.
- Include sodium bicarbonate to counteract acidosis.
- Slightly increase vitamin C levels.

These measures help minimize the impact of heat on the hen's metabolism, ensuring better egg quality (Lin et al., 2006).

CONCLUSION

Egg quality is not the result of a single factor but of the dynamic interaction between nutrition, environment, and management. A well-formulated diet, rich in key nutrients such as calcium, phosphorus, essential amino acids, and antioxidants, provides the physiological foundation for quality production. At the same time, environmental control—particularly regarding temperature, ventilation, humidity, and lighting—is essential for maintaining the welfare of layers and avoiding production losses.

Implementing integrated strategies addressing these aspects not only improves shell quality and internal egg content but also prolongs the flock's productive life, reduces losses, and contributes to more efficient and sustainable production.



In an increasingly demanding and competitive market, optimizing these factors represents a key tool for ensuring producer profitability and differentiation.

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