CRITICAL POINTS IN THE NUTRITION OF LAYING HENS

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Modern laying hens have a high genetic potential to produce eggs. If they receive adequate environmental conditions, health, and nutrition, they can maintain over 90% of the laying rate for a long period of the productive cycle.

In the last decade, we have seen how genetic progress has generated laying hens with an extraordinary productive persistence, accompanied by a slight decrease in body weight, feed intake, and egg size, reaching 50% production earlier than ten years ago.

Modern laying hens, a challenge for nutritionists

Modern laying hens represent a challenge for nutritionists, as one can no longer entirely rely on scientific information generated in the past with other types of birds.

- One could think of an increase in nutritional requirements. However, they still produce one egg per day, with slightly reduced daily egg mass. Therefore, daily nutritional requirements should not have increased; hence the importance of **considering the nutritional requirements of the hen in the laying phase based on a daily intake of nutrients**

The importance of reaching the bodyweight during rearing

One of the frequent problems **today is in birds that are reaching peak production and cannot consume enough feed. Thus, they have to rely on their fat and bone structure to compensate for the lack of nutrients, generating a typical drop-in production that will impact the performance of the hens for the rest of their days if stocks are not adequate and demand is high.**

Therefore, it is necessary to prepare the layers to start the lay with a suitable size and bodyweight:

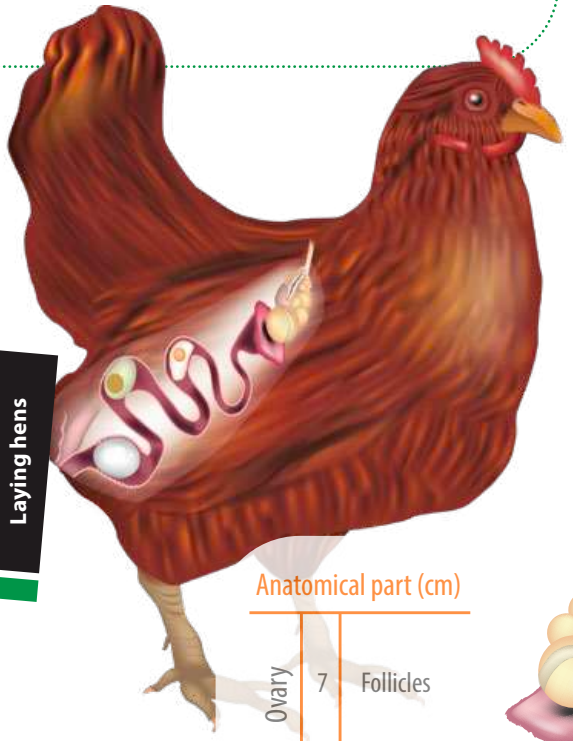
- A feed intake of at least 95 g and ideally 100 g daily with an adequate calcium reserve means a well-formed medullary bone.

To interrelate the above parameters, the rearing diets must stimulate the increase in the size of the digestive tract and increase the levels of fiber. It is also important to use feed with a granulometry of around 1.0 to 1.2 mm from the fifth week of age.

- It is recommended to use fiber levels of 3.5% from 5 – 11 weeks and 3.5 to 4.5% from 12 to 18 weeks of age.
- Pullet rearing diets from 0 – 4 and 5 – 11 weeks of age should be formulated with no less than 18 and 16% protein, respectively, with corresponding amino acids to ensure good growth.
- Metabolizable energy levels should not drop below 2,750 kcal/kg after 12 weeks.

Bone formation

For bone formation, the nutrition of calcium, phosphorus, and vitamin D3 during growth is essential. Maintaining the proper ratio between available calcium and phosphorus and providing adequate levels of these minerals during pre-laying for proper medullary bone formation.



Medullary bone formation begins about ten days before laying, and the bird's skeleton increases by 20%. This is due to a hormonal synergism of estrogens and androgens that indirectly increase the absorption and retention of calcium and phosphorus.

- This process is reflected externally with the growth and coloration of the comb and barbels. It is completed by around 30 weeks of age.
- During laying, the formation of the medullary bone occurs between each ovulation and is due exclusively to the action of estrogens.
- The calcium in this bone (approximately 1 g) is always available for eggshell formation.
- It is necessary to deliver enough nutrients to the diet at the right time for this process to work. Otherwise, marrow reserve will be maintained at the expense of structural bone, resulting in leg weakness and cage fatigue.

	Anatomical part (cm)		Functions	Time
Ovary	7	Follicles	Gamete formation	150 days
			Yolk deposit	10 days
Oviduct	9	Infundibulum	Fertilization vitelline membranes	20m
	33	Magnum	Albumen deposit	3h30m
	10	Isthmus	Testaceous membranes	1h15m
	10	Uterus	Albumen Hydration Eggshell formation	21h
	10	Cloaca	Oviposition	1h30m

From 24 to 26 hours

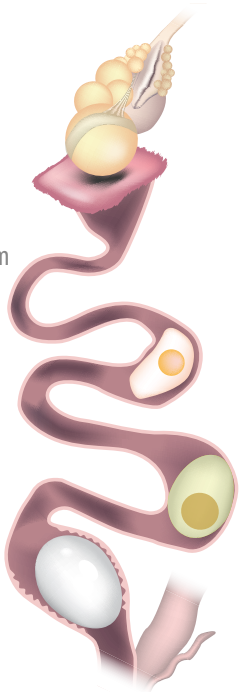


Diagram of the egg formation.

Calcium

The particle size of the calcium source is one of the essential measures to maintain good eggshell quality.

- **Particles larger than 2 mm are retained in the gizzard and slowly solubilized, delaying the assimilation of calcium.**
- **This dietary calcium will be available during the night when the greatest calcification of the eggshell occurs. The hen will not rely exclusively on the medullary bone's calcium.**

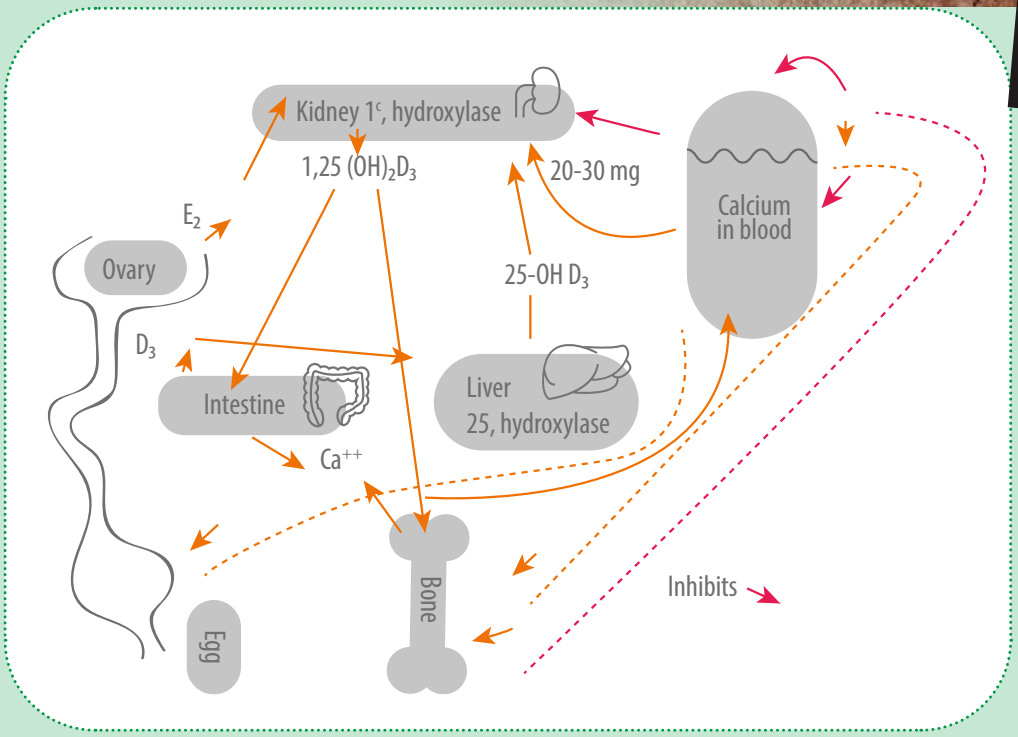


Figure 1. Calcium homeostasis (modified from Soares 1984)

Phosphorus level

The dietary level of available phosphorus is also important in the quality of the eggshell. An appropriate level and ratio of available calcium and phosphorous are necessary for optimal bone calcification and medullary bone formation during bird growth.

- However, during laying, a relatively high level of available phosphorus inhibits calcium mobilization from bone;
- Because although there is availability of dietary calcium during the night, the hen will always resort to the medullary bone to obtain part of the calcium that goes to the eggshell. Also, the mobilization of calcium from the bone implies the presence of a high level of phosphorus in the blood.

Therefore, limiting the level of available phosphorus in the diet, especially after 60 weeks of age, is necessary to improve eggshell quality.

Vitamin D3

Adequate vitamin D3 inclusion in the diet is essential for good bone and eggshell calcification.

Metabolites of vitamin D3 are currently available to increase calcium retention and reduce mortality.

Zinc, manganese, and copper

It is also crucial that the diet contains adequate zinc, manganese, and copper levels because they participate in the formation of the internal membranes or cuticles of the eggshell and the organic matrix of the shell.

- Zinc aids in the availability of carbonate to form calcium carbonate in the eggshell. The addition of these minerals through a good organic source has been found to be more beneficial.

Heat stress and eggshell quality

When hens are under heat stress, the continuous panting generates a drop of carbonate in the blood and the consequent deterioration of the quality of the eggshell due to due to a lack of carbonate.

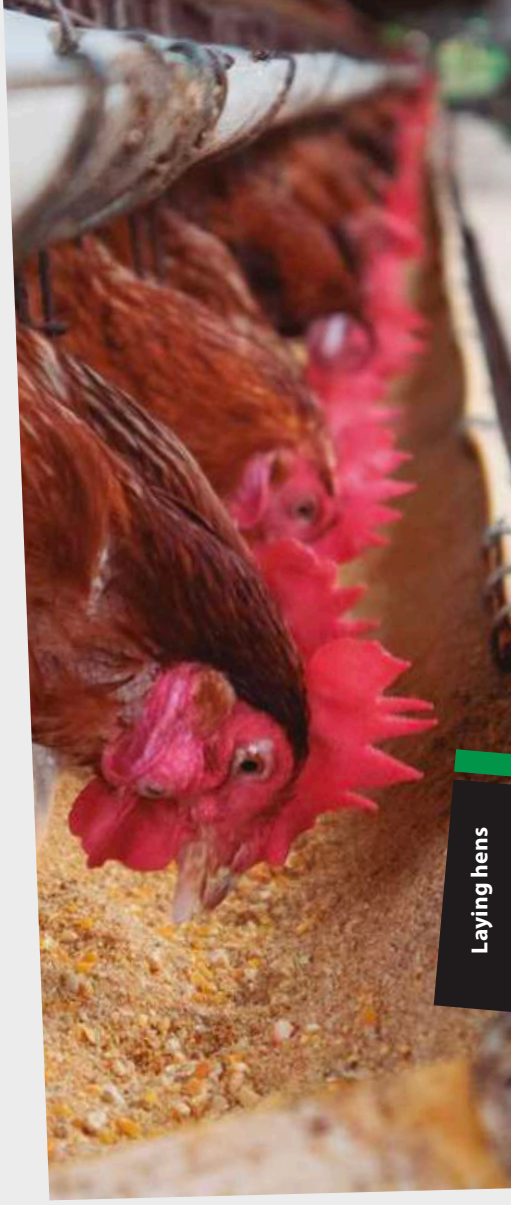
- **To improve the situation, in this case, the use of sodium bicarbonate in the diet up to a maximum of 0.3% should be adviced to replace salt.**
- **Furthermore, vitamin C can be added to the diet, which favors converting 25(OH) D3 to 1,25(OH)2 D3.**
- **Feed and water consumption can also be increased with one additional hour of nightlight.**

Feed selection by the hen

Laying hens need a minimum daily intake of metabolizable energy of 280 to 300 kcal/kg with a balanced intake of digestible amino acids, minerals, and vitamins to ensure adequate egg production and size.

When the hen is in production, it can select different diet components during the day.

- This is a very efficient process, so it is recommended to present a feed where the grain and the calcium source have a particle size between 3 and 5 mm, promoting its selection.
- At least 2% additional oil or high lipid ingredients, such as whole soybeans, are recommended to reduce dust and assist the bird with finer feed selection.



Levels equal to or greater than 17% crude protein have traditionally been used in laying hen diets. However, the current trend is to formulate based on the essential digestible amino acid requirements.

- Excessive levels of protein in the diet not only means a high additional cost of the formula but can also affect the productive performance of layers, especially when the hens are under heat stress conditions.

- Its digestion and metabolism generate an unnecessary body caloric increase, circulating amino acids increase, decreasing appetite and causing the excretion of excessive amounts of uric acid, with energy expenditure, which will ultimately increase environmental pollution.

It is important to mention that laying hens do not have a crude protein requirement. They only need an amount that ensures a sufficient nitrogen reserve to synthesize dispensable amino acids.

During the last decade, many studies **have been carried out to determine the daily needs of amino acids in laying hens**. Therefore, formulating a proven practice based on the essential digestible amino acid requirements. Layers fed a 13 to 14% protein diet, adequately supplemented with pure amino acids (methionine, lysine, tryptophan, arginine, threonine, valine, and isoleucine) have been shown to perform optimally, similar to those fed a control diet with 16% or 18% protein.

Accurate and reliable values of digestible amino acids in the ingredients are essential to obtain these results.

Critical points in the nutrition of laying hens

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The amount of information that has been generated about the digestibility of amino acids in raw materials and the required levels allows us to formulate laying hen diets with greater precision. ***Table 1*** shows the updated range of suggested daily intake levels of digestible amino acids for laying hens.

Digestible amino acid	Ideal relationship	mg/day
Lysine	100	800 - 750
Lethionine	50	400 - 375
Met + Cys	88	705 - 660
Arginine	105	840 - 790
Threonine	72	575 - 540
Tryptophan	21	170 - 160
Valine	89	710 - 670
Isoleucine	79	630 - 590
Leucine	120	960 - 900

Table 1. *The suggested ratio of digestible amino acids for laying hens.*

CONCLUSION

It is a great challenge to adapt the nutritional programs required by the new genetic strains of laying hens. They are very efficient birds with a great propensity to produce eggs and, therefore, more sensitive to any nutritional alteration.