Solanum glaucophyllum in layer hen diets to reduce dietary phosphorus

Modern laying hens have a huge potential to produce affordable and high quality animal protein. In current practice, layers can produce over 500 eggs per hen-housed, whereas the potential of certain genetics under optimal conditions is already at least 30% higher.

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Bird management and nutrition are key factors to realise this huge genetic potential, considering:

- Nutrition or 'dietary nutrient intake' should enable this high productivity, not challenging birds' health and welfare.
- Egg production must be environmentally sustainable and minimise nutrient excretion per kg animal product, including CO_2 emission, to improve the carbon footprint of egg production.

In the end, the central question is how we can support the hen to produce such a high number of eggs with a good eggshell quality as efficiently as possible, without challenging her health and welfare.

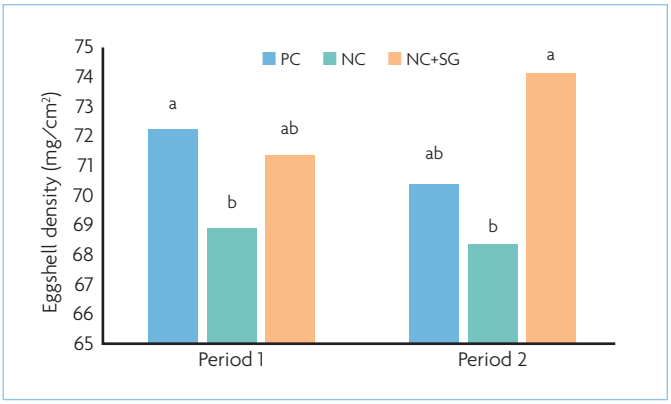
An efficient calcium (Ca) metabolism to maximise Ca absorption from the intestinal tract throughout life and to reduce the need for bone mobilisation can be supported by Solanum glaucophyllum (SG), a plant that is naturally producing 1,25(OH)$_2$D$_3$-glycosides as a source of the metabolically active form of vitamin D$_3$.

1,25(OH)$_2$D$_3$-glycosides and calcium absorption in aged layers

Although a laying hen is genetically able to produce 500 eggs or more, the eggshell quality worsens with age, which is related to a reduced efficiency of intestinal Ca absorption when the bird gets older. This age effect is related to a compromised activation of 25(OH)D$_3$ into its metabolically active form due to a lack of 1α-hydroxylase activity in the kidney. As a 'solution', nutritionists are increasing dietary Ca contents to try to compensate for this age effect, although it could adversely affect nutrient digestibility and phytase efficacy. The efficacy of dietary supply of 1,25(OH)$_2$D$_3$-glycosides from SG on eggshell quality in moulted Lohmann Brown laying hens was tested between 110-120 weeks of age. A positive control group (PC) fed a diet with 3.7% Ca was compared with a negative control (NC) with 2.7% Ca. The NC group was also fed with 10µg 1,25(OH)$_2$D$_3$-glycosides from SG per kg feed (as 1kg Panbonis/ton feed).

All diets contained 2,800 IU/kg vitamin D$_3$ and 2.7g/kg available P (avP). Eggshell density in the NC + SG group was at least like the PC group in the first four-week response period. In the second four-week response period, effects were even more pronounced (Fig. 1).

Fig. 1. Eggshell density in aged laying hens fed a normal (PC: 3.7% Ca) and low (NC: 2.7% Ca) dietary Ca content. The NC was also fed with SG.



	Control	Control + SG
Egg production (%)	86.7^b	90.4^a
Egg weight (g)	66.5	66.0
FCR (kg/kg egg)	1.85^a	1.77^b
Eggshell density (mg/cm^2)	71.4^b	79.3^a
Eggshell strength (kgf)	2.53^b	3.74^a

Values with different superscript letters are significantly different (P<0.05).

Table 1. Production performance and eggshell quality of aged laying hens fed a control diet as such or supplemented with 1µg 1,25(OH)$_2$D$_3$-glycosides from Solanum glaucophyllum (SG).

This trial thus indicates an increased efficiency of Ca utilisation in hens fed diets supplemented with 1,25(OH)$_2$D$_3$-glycosides. Daily egg mass, feed intake and FCR were not different between treatments.

The increased efficacy in Ca utilisation reduces the need for mobilisation of medullary bone during eggshell formation, and consequently the excretion of phosphate via the kidney.

This reduces the need for dietary phosphate to replenish medullary bone during the period without eggshell formation and lowers phosphate requirements.

The increased Ca utilisation was confirmed in a trial with the recommended dose of 1,25(OH)$_2$D$_3$-glycosides. Adding 1µg 1,25(OH)$_2$D$_3$-glycosides from SG per kg feed (as 100g Panbonis/kg) to a diet of LSL-Lite laying hens between 110-120 weeks of age improved performance and eggshell quality parameters (Table 1). The phytase supplemented diets contained 3.8% Ca, 0.25% avP and 2,700 IU vitamin D$_3$/kg.

Phosphorus requirement in laying hens

Several studies were published on the phosphorus (P) requirements in laying hens up to 100 weeks of age. The highest avP requirement that was reported in those studies from 20-100 weeks of age was 2.9g avP/kg feed. The main fraction of this dietary P is needed to restore medullary bone that was mobilised for Ca homeostasis during the previous day.

As discussed, improved intestinal Ca absorption reduces the need for bone mobilisation and the excretion of P via the kidneys and thus the avP requirements. This supports the idea that avP contents in the diet, which are recommended in the laying hen management guides, can be reduced without negative effects on bone or eggshell quality if the efficiency of Ca utilisation is improved.

1,25(OH)$_2$D$_3$-glycosides and phytase in laying hen diets

As bacterial phytase formulations efficiently hydrolyse phytate-P in layers, (values up to 60-70% have been reported), laying hen diets can be formulated that meet the avP requirement without adding inorganic phosphate to the diet.

Moreover, dietary inclusion of 1µg 1,25(OH)$_2$D$_3$-glycosides/kg diet from SG (as 100g Panbonis/kg) stimulates Ca utilisation in laying hens throughout life, prevents the need for increased dietary Ca contents with age, and limits excretion of phosphate via the kidneys.

Of course, the presence of Ca during the night via dietary supply of coarse limestone is a requisite to improve intestinal Ca absorption throughout the day. ■