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CALCIUM FOR LAYERS – HOW MUCH AND WHEN?

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Egg shell damage resulting in egg loss or reduced value is a major problem in the poultry industry. Many factors contribute to this loss: longer periods of high production, greater bird density in cage housing systems, and increased use of mechanical equipment to collect and process eggs. High environmental temperatures and the physiological changes associated with aging also have resulted in reduced shell quality. In addition to management, a number of nutrients including calcium, phosphorus, vitamin D_3, and the trace elements zinc and magnesium influence shell quality.

Calcium and Shell Formation

Calcium is the nutrient most directly involved in egg shell formation. Large eggs, weighing 24 ounces per dozen or 56 grams each, are 8 to 9 percent shell. This 4.5 to 5.0 grams of shell, which the hen deposits in the surface of the shell membranes, contains 1.8 to 2.2 grams of calcium in the form of calcium carbonate.

Shell formation demands a major portion of the time required for the total egg formation cycle. The egg spends about 20 of the total 25 to 26 hours in passage through the oviduct in the shell gland. So, almost 80 percent of the time required for egg formation, not counting the 8- to 10-day period during which yolk matures in the ovary, is spent in shell formation.

The calcium needed for shell formation is derived from two sources. Part is supplied directly from the feed as it is absorbed from the gut. However, shell formation is occurring during the nighttime hours also when the hens are not consuming feed and the crop and gut are empty. At this time calcium is supplied by a unique calcium storage system in the bones of the actively laying hen. Calcium is deposited here during non-shell forming periods and is then called on to supply calcium via the blood stream when the diet cannot meet the demands for shell formation. From these two sources the shell gland of the oviduct receives the calcium needed for shell formation.

Calcium Feeding Programs

A free-choice oyster shell feeding program has been used with birds on floor systems. This may be satisfactory provided the layer ration contains only 2.0 percent calcium. Today it is easier and results are generally more satisfactory to use a complete feed and to include all the calcium in the ration.

Many flocks are fed a layer ration providing a constant level of dietary calcium through the entire production cycle. This may be necessary for smaller flocks where ration changes cannot be made easily. Then, a dietary calcium level of 3.00 to 3.25 percent should be used for floor birds and 3.25 to 3.5 percent for cage birds.

With today's larger commercial flocks and better management, it is desirable to formulate rations specifically to the needs of individual flocks. Here calcium phase feeding programs can be used where dietary calcium levels and daily calcium intake are adjusted during the laying period in relation to age of the hens and their feed intake as influenced by age, production rate, and environmental temperature. The number and frequency of ration changes will depend on the size of the flock, the availability of feed consumption records, and the willingness and ability of the feed manufacturer to change formulas on demand. Often a phase feeding program can be developed around 3 or 4 calcium levels for use with young to old birds and during cool or hot weather.

Meeting the Calcium Needs of the Hen

To arrive at the proper dietary level of calcium or percent calcium in the ration, think first in terms of the hen's daily calcium requirements. The hen will retain only about 50 to 60 percent of the calcium in the ration. If each egg contains approximately 2 grams of calcium, with calcium retention of 50 percent and egg production of 80 percent, the hens will need to consume about 3.2 grams of calcium daily. Calcium utilization is probably best and shell quality problems fewest in younger birds so a dietary calcium level is recommended which will provide a daily calcium intake of 3.0 to 3.2 grams per day during the first 40 weeks of production.

Shell quality may decline after 40 weeks because egg size is larger, calcium utilization may be poorer, and the ability of the shell gland to form sound shells may be decreased because of age and sustained high production. Although flock production may be below 80 percent, many individual birds are still producing at this rate. To compensate for some of these changes, a 20 percent greater daily calcium intake, or 3.6 to 3.8 grams per bird per day, may be desirable. A change in the dietary calcium level should be made to provide this amount.

An estimate of the daily feed intake of the flock is also needed to arrive at the proper dietary calcium level or percentage calcium needed in the feed. Feed intake will vary with age -- young pullets are smaller in body size and will consume less feed than older hens. The egg production rate of the flock also affects feed intake. Also, dietary energy level and environmental temperature have a marked influence in feed intake because chickens consume feed to meet their energy needs. So feed intake will be greater at cool temperatures or with low energy rations and less during hot summer months or with high energy rations. Records of a flocks' feed intake can be a useful management tool in addition to estimating dietary nutrient density requirements.

Putting all this information together–age of flock, feed intake, and desired daily calcium intake–table 1 can be used to arrive at the desired percentage calcium needed in the layer ration for a specific flock. This table shows the daily calcium intake for varying feed intakes and dietary calcium levels. If young pullets needing 3.0 to 3.2 grams of calcium per day are consuming an average of 20 pounds of feed per 100 birds per day, the ration will need to contain 3.4 percent calcium to provide 3.1 grams of calcium per bird per day. An older flock 65 weeks of age consuming 23 pounds per 100 birds per day needs 3.8 grams of calcium so the ration should contain 3.6 percent calcium.

Recent Calcium Research

A recent experiment at the University of Minnesota studied dietary calcium feeding programs. Three constant dietary calcium levels, two calcium phase feeding sequences, and free-choice oyster shell with high and low dietary calcium were compared. A treatment involving a periodic low calcium stress (1.5 percent calcium 7 days out of each 28 days) was also included. The effects of these 8 treatments on cage layer performance and shell quality were measured over an 84-week production period (table 2).

Results suggest that the calcium phase feeding sequences (either a 5 step sequence of 1.5-2.5-3.25-4.00-4.75 percent calcium or a 2 step sequence of 3.25 and 4.00 percent calcium) gave the best overall results in terms of egg production rate and shell quality. The 1.5 percent calcium plus oyster shell treatment resulted in poor shell quality throughout the 84-week period and the calcium stress diet gave poor shell quality particularly during the last 20 weeks of the experiment. The two diets providing the highest calcium intake–the constant 4.5 percent calcium diet and the 3.5 percent calcium plus free-choice oyster shell–resulted in a 5 to 10 percent lower production rate during the last 20 weeks of lay, although shell quality was good. These data support the concept of feeding a calcium level adequate, yet not excessive for hens' needs.

Other research suggests that the use of oyster shell or large particle-size limestone grit to replace 1/2 to 2/3 of the finely ground limestone normally used in layer rations may improve shell quality. Work at Cornell University showed that hen-size oyster shell flakes were retained in the gizzard and digested more slowly than ground limestone. During the nighttime hours the slower release of calcium from oyster shell provided a continued source of calcium from the gut for shell formation. A similar effect has been demonstrated in other studies using large particle-size limestone. The use of oyster shell or limestone grit may also provide an identifiable source of calcium so that individual birds may balance their calcium intake by selection. If large calcium particles are included in the ration, they should replace an equivalent amount of ground limestone and not be in addition to the regular ration. Also automatic feeding systems should be checked to see that there is not excessive ingredient separation along the cage row.

Another innovation is the use of a 1-hour light period in the middle of the night or dark period to encourage birds to eat and refill their crops. This also should provide for a more continuous absorption of calcium and other nutrients during shell formation.

When severe shell quality problems occur, top-dressing oyster shell or limestone grit on the feed has been beneficial sometimes. However, this should not be done indiscriminately as excessive calcium should not be fed. This can lead to erratic calcium intakes, nutrient imbalances, and other problems such as reduced production.

In summary, egg shell quality is a major problem to the poultry industry and adequate calcium nutrition is one factor to consider in reducing or preventing excessive losses.

Table 1. Daily calcium consumption as influenced by daily feed intake and percent calcium in the ration

Daily feed consumption		Percent calcium in ration						
pound/100 bird	gram/bird	2.8	3.0	3.2	3.4	3.6	3.8	4.0
		Grams per day						
18	82	2.3	2.5	2.6	2.8	3.0	3.1	3.3
19	86	2.4	2.6	2.8	2.9	3.1	3.3	3.4
20	91	2.5	2.7	2.9	3.1	3.3	3.5	3.6
21	95	2.7	2.9	3.1	3.2	3.4	3.6	3.8
22	100	2.8	3.0	3.2	3.4	3.6	3.8	4.0
23	104	2.9	3.1	3.3	3.6	3.8	4.0	4.2
24	109	3.1	3.3	3.5	3.7	3.9	4.1	4.4
25	114	3.2	3.4	3.6	3.9	4.1	4.3	4.6
26	118	3.3	3.5	3.8	4.0	4.2	4.5	4.7

Table 2. Effect of calcium feeding programs on egg production and shell quality over 15, 4-week periods (exp. H-163)

Treatment	Hen-day production (percent)	Shell thickness (inches)	Shell (percent)
2.5% Calcium	79.3	.0123	8.50
3.5% Calcium	78.0	.0121	8.59
4.5% Calcium	73.9	.0124	8.77
Ca Phase (5)	78.7	.0126	8.69
Ca Phase (2)	77.7	.0127	8.77
Ca Stress	79.3	.0119	8.34
1.5% Ca & O.S.	78.1	.0118	8.29
3.5% Ca & O.S.	74.8	.0128	8.94

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