# Vitamin Enrichment of Eggs

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**Primary Audience:** Egg Producers, Nutritionists

## SUMMARY

**Layers were fed diets with regular or 3 to 10 times more supplemental vitamins in an attempt to enrich eggs with these nutrients. Dietary concentrations of vitamins were chosen with the expectation of producing an egg with sufficient vitamins to achieve 50% of daily recommended intake (DRI). Eggs were assayed for all vitamins following a 90-d feeding period. There was considerable variation in egg vitamin enrichment. Only for biotin, vitamin $B_{12}$, and vitamin K was ≥50% DRI achieved with one egg. Egg content of niacin, thiamine, and pyridoxine were insensitive to diet manipulation.**

**Key words: egg, vitamin**

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## DESCRIPTION OF PROBLEM

So-called designer eggs now represent over 5% of all shell eggs sold in Canada, and similar trends are occurring in the United States. These eggs are enriched in omega-3 fatty acids, which benefit human nutrition. Most of these eggs are also enriched in vitamin E, ostensibly as an additional antioxidant to protect the long-chain polyunsaturates. It seems feasible to enrich the egg with other vitamins. Naber [1] reviewed the potential efficiency of transfer of vitamins from feed to eggs and concluded that four general categories exist (low, medium, high, and very high) in which efficiency varies from 5 to 80%. In fact, egg vitamin content is suggested as a measure of dietary adequacy [2, 3]. Although some interactions exist among the uptakes of certain vitamins [4, 5] there does not seem to be any potential problem in layer performance with feeding much higher than normal levels of vitamins [6]. A 3-mo study was conducted to investigate the potential of meaningfully enriching eggs with most vitamins. The goal was to produce an egg that provided 50% of daily recommended intake (DRI) for all vitamins.

## MATERIALS AND METHODS

Sixty White Leghorn hens at 40 wk of age were randomized into individual layer cages and fed one of two diets differing in vitamin content. The level of vitamin enrichment was chosen based on previous work of Naber and coworkers [1, 2] who showed variable efficiency in transfer of vitamins from diets to egg. Consequently, higher diet levels were chosen for vitamins with low transfer efficiencies and vice versa. Egg production was at 94% at the start of the trial and declined, unaffected by diet, to 89% at the end of the trial when birds were 52 wk of age. The corn-soy diet and composition of the vitamin premixes are shown in Table 1. The premixes contained comparable levels of trace minerals and choline.

Eggs were collected from all birds after providing the diets for 90 d. Although vitamin en-

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TABLE 1. Diet and vitamin premix composition

| Ingredient | Diet (% composition) | Vitamin | Premix vitamin levels[A] Regular | Enriched | Increase (%) |
|---|---|---|---|---|---|
| Corn | 63.56 | Vitamin A (IU/kg) | 10,000 | 40,000 | 300 |
| Soybean meal | 23.00 | Vitamin $D_3$ (IU/kg) | 3,500 | 8,500 | 143 |
| Limestone | 9.00 | Vitamin E (IU/kg) | 30 | 230 | 670 |
| Dicalcium $PO_4$ | 1.50 | Vitamin K (mg/kg) | 3 | 8 | 166 |
| Animal fat | 1.50 | Vitamin $B_1$ (mg/kg) | 4 | 24 | 500 |
| Salt | 0.30 | Vitamin $B_2$ (mg/kg) | 6 | 31 | 420 |
| DL-Methionine | 0.14 | Vitamin $B_6$ (mg/kg) | 5 | 15 | 200 |
| Premix[1] | 1.00 | Biotin (mg/kg) | 0.2 | 1.2 | 500 |
| | 100.00 | Folic acid (mg/kg) | 1 | 3 | 200 |
| | | Niacin (mg/kg) | 40 | 440 | 1,000 |
| | | Pantothenic acid (mg/kg) | 10 | 20 | 100 |
| | | Vitamin $B_{12}$ ($\mu$g/kg) | 10 | 110 | 1,000 |
| | | Choline (mg/kg) | 1,200 | 1,200 | 0 |

[A]Provided per kilogram diet. Trace mineral levels were constant: Cu, 9 mg/kg; Mn 80 mg/kg; Zn, 80 mg/kg; Fe, 60 mg/kg; Se, 0.3 mg/kg. Antioxidant as ethoxyquin also constant at 120 mg/kg. Vitamin levels as shown above.

richment of eggs is expected to stabilize within 15 to 25 d of diet manipulation, a longer feeding period was used in order to observe any gross changes in bird behavior, egg production, or egg quality characteristics.

Eggs were broken, and entire contents were homogenized. Eggs were pooled from 2 d of collection from birds in adjacent cages to give eight replicate, homogenized samples per treatment. Samples were frozen and then freeze-dried to constant weight. Subsamples were reground using a Waring blender and then allowed to equilibrate with ambient moisture at room temperature. Samples were assayed for all vitamins by Woodson-Tenent Laboratories, Inc. [7]. Moisture content of samples was determined by freeze-drying to constant weight.

## RESULTS AND DISCUSSION

Vitamin contents of regular and modified eggs are shown in Table 2. Diet vitamin level had no effect on general bird performance or behavior. Only in very few instances was the modified egg sufficiently enriched to produce a 60-g egg with 50% DRI of any vitamin. Vitamin $B_{12}$ showed perhaps the best response, increasing from 36 to over 100% DRI in response to an 11-fold increase in diet vitamin supplementa-

TABLE 2. Vitamin content of 60-g eggs ($\mu$g)

| | DRI[A] | Regular egg Content | DRI (%) | Modified egg Content | DRI (%) |
|---|---|---|---|---|---|
| Vitamin A | 900 $\mu$g | 59 ± 25 | 6.6 | 75 ± 2 | 8.3 |
| Vitamin $D_3$ | 10 $\mu$g | 0.39 ± 0.03 | 3.9 | 1.14 ± 0.005 | 11.4 |
| Vitamin E | 15,000 $\mu$g | 1,320 ± 80 | 8.8 | 3,760 ± 260 | 25.1 |
| Vitamin K | 120 $\mu$g | 130 ± 3 | 108.0 | 130 ± 1 | 108.0 |
| Thiamin | 1,200 $\mu$g | 49 ± 1 | 4.1 | 67 ± 2 | 5.6 |
| Riboflavin | 1,300 $\mu$g | 219 ± 31 | 16.8 | 245 ± 36 | 18.8 |
| Pyridoxine | 1,300 $\mu$g | 27 ± 2 | 2.1 | 33 ± 3 | 2.5 |
| Biotin | 30 $\mu$g | 17 ± 2 | 56.6 | 18 ± 0.5 | 60.0 |
| Folic acid | 400 $\mu$g | 9 ± 0.00 | 2.3 | 10 ± 0.00 | 2.5 |
| Niacin | 16,000 $\mu$g | 47 ± 6 | 0.3 | 77 ± 33 | 0.5 |
| Pantothenic acid | 5,000 $\mu$g | 763 ± 165 | 15.3 | 1,205 ± 183 | 24.1 |
| Vitamin $B_{12}$ | 2.4 $\mu$g | 0.87 ± 0.04 | 36.3 | 3.35 ± 0.11 | 139.0 |

[A]Daily recommended intake for adult male 30 to 40 yr of age.

tion. Although more than 50% of DRI was also recorded for vitamin K and biotin, levels in the modified eggs were little different to those observed in regular eggs. There was meaningful egg enrichment for vitamins $D_3$ and E, and the level of pantothenic acid was doubled. Although the level of niacin was increased by 64% in the modified egg in response to a 10-fold increase in premix level, the actual per egg yield of niacin was insignificant in relation to DRI.

With some notable exceptions, therefore, we were unable to realize meaningful increases in egg vitamin content relative to DRI. A number of deleterious interactions occur for certain groups of vitamins [4, 6, 8, 9] and especially between vitamins A and $D_3$. However most of these interactions become noticeable when one vitamin is in excess and the other is borderline deficient. There are few reports of any interactions among vitamins when all are presented at higher than normal levels. From the current data, it seems unlikely that eggs can be enriched simultaneously with all vitamins and that the current niche market for vitamin E or $B_{12}$ enrichment alone seems the best approach in producing designer eggs for specific needs.

## CONCLUSIONS AND APPLICATIONS

1. By using a fortified vitamin premix, it was hoped to produce designer eggs with at least 50% DRI of all vitamins.
2. After birds were fed diets for 3 mo, eggs collected from hens fed control and vitamin-fortified diets were assayed for all vitamins.
3. Increasing all dietary vitamins concurrently generally had little impact on egg vitamin status.
4. Only for vitamin $B_{12}$ was there meaningful increase in egg content relative to DRI. Vitamins $D_3$ and E were also enriched with levels to 11 and 25% of DRI, respectively.

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