EFFECTS OF FEEDING PROVITAMIN A, STABILIZED VITAMIN A, AND PURABOLIDONE ON PRODUCTION AND QUALITY OF EGGS

by

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INTRODUCTION

The discovery by Steenbock(1919) that carotene in leaves and other natural products contained a vitamin A active substance opened a new era in the field of animal nutrition. An adequate supply of carotene or vitamin A must be present in the diet of all animals for normal well being. Emmett and Peacock(1923) demonstrated that chickens could use alfalfa extract as a source of fat-soluble vitamin A. Much work has been done since 1930 to prove the efficacy of carotene, from dried or dehydrated alfalfa meal, as a source of vitamin A in poultry rations. There appears to be strong agreement among workers that carotene is utilized efficiently by poultry as a vitamin A source; however, results obtained by others are not in agreement with this work.

Some of the nitrofurans, which have been given attention during the past few years as antimicrobial drugs, are now also used as feed additives in poultry rations. As a matter of fact, modern poultry rations have become carriers for many of the feed additives. Furazolidone[1], a nitrofuran compound is synthesized from agricultural by products such as corn cobs, oat hulls and wheat husks. Several inconsistencies in egg production and feed utilization have been reported by various workers with the use of furazolidone as a feed additive in layer rations depending, upon the strains of birds, housing conditions, management methods, and environmental conditions.

1. Supplied as nf-150(R) which contains 50 grams of furazolidone per pound of supplement.

The role of furazolidone in layer rations, affecting the quality and component parts of the egg, opens a wide field for investigation by researchers.

In view of these facts, attention has been focused in this experiment to study: 1. the effect on egg production of feeding provitamin A from a dehydrated alfalfa source or stabilized vitamin A, with furazolidone. 2. the effect produced by the combinations on the quality and component parts of eggs. The criteria used for measurement were: egg weight, yolk wieght, shell weight, per cent yolk, per cent shell, Haugh units, per cent egg production, feed efficiency and mortality. In addition, at the time of break-out, observations were made for blood spots and blood streaks.

REVIEW OF LITERATURE

Following the work of Emmett and Peacock(1923), who found that chickens could utilize alfalfa extracts as a source of fat-soluble vitamin A, numerous research investigations have determined the efficacy of feeding provitamin A for growth, general condition, production and reproduction.

Moore(1930) demonstrated that vitamin A depleted rats were able to store vitamin A in the liver when beta-carotene was included in their diet. This was followed by the work of Bolin et al.(1943) who reported that carotene could be utilized as a source of vitamin A by chickens, by the end of first week. Work conducted at Kansas State University by Harvey et al.(1955) proved that chicks less than 12 hours old were able to convert

carotene from dehydrated alfalfa sources to vitamin A.

The National Research Council(1960) recommended equal units of vitamin A activity from carotene or from true vitamin A for growing chickens. This is in agreement with the work of Wilson et al.(1936), Record et al.(1937), Petering et al.(1941), and Kramke et al.(1952), but differs from the work of Camp et al.(1955), Ely(1959), Gledhill and Smith(1955), who reported carotene is not utilized efficiently by poultry as a vitamin A source.

The National Research Council(1960) recommended 2,000 U.S.P. units of vitamin A per pound of feed as adequate for normal egg production. However, better results were obtained with an increased amount of vitamin A, at levels considerably in excess of recommended requirements (Parrish and Sanford, 1960; Zimmerman et al., 1961).

Erasmus and Scott (1960) observed that 800 I.U. of vitamin A per pound of feed, under normal conditions, failed to promote growth to the same extent as 8,000 I.U. per pound of feed after the chickens were infected with coccidiosis.

No deterimental effect on egg production was noted with dietary vitamin A levels up to 200,000 I.U. per pound of feed (Deuel et al. 1943). However, there was progressively greater supression in carotenoid pigment of egg yolks with the increase in vitamin A intake.

At a therapeutic level, Donovan and Duncau(1962) used 0, 10,000 and 110,000 I.U. per pound added provitamin A in the diet of White Rock Pullets. The pullets were confined to wire

cages and assigned to one of the three dietary levels. Consistent decline in egg production resulted after three weeks on the highest vitamin A level with no marked difference between the two lower levels. There were no significant difference among the vitamin A levels regarding egg weight, shell strength or shell thickness. Furthermore, Haugh units did not improve significantly in groups receiving the two highest levels of vitamin A. Meat and blood spots of eggs were significantly greater and yolk color was significantly lighter for the groups on highest level of vitamin. The hatchability of fertile eggs was decreased significantly on the 110,000 I.U. level of vitamin A per pound of feed.

William et al. (1938) used dehydrated alfalfa as the source of carotene for laying hens, ranging from 0.1 mg to 0.5 mg per bird per day. The results indicated that 0.1 mg was inadequate and 0.5 mg achieved increases in egg production and hatchability which were statistically slightly significant. Feeding 0.25 mg of carotene per bird per day was adequate to promote normal egg production, and to prevent development of deficiency lesions.

Johnson and co-workers(1948) reported using 1,200 units of vitamin A activity per 100 grams of feed from two different sources: fish liver oil and carotene from dehydrated alfalfa. Results obtained from their study showed that rate of growth and rate of liver storage of vitamin A was less in lots receiving vitamin A activity from fish liver oil as compared to that with carotene provided by alfalfa meal.

Beta-carotene was not as effective as vitamin A in maintaining body weight or storage of vitamin A in the liver, at levels

ranging from 250 to 32,000 U.S.P. units of carotene and vitamin A per pound of feed. This was demonstrated by Guraay, Boucher and Callenbach (1948) when vitamin A- low diets of White Holland turkey poults were supplemented with vitamin A and carotene.

Rubin and Bird(1941) used separately cod liver oil, carotene and alfalfa leaf meal as sources of vitamin A activity in the diet of chicks, and observed that storage of vitamin A in the liver was increased with the increase of vitamin A or carotene in the ration. The groups receiving alfalfa meal showed consistently better storage of vitamin in the liver, at the 450 microgram level, as compared to the same level in other two groups.

The work of Frey and Wilgus(1949) reveals the storage of more vitamin A in the liver of pullets receiving 2,000 I.U. of vitamin A activity from fish liver oil than from dehydrated alfalfa. However, the highest content of vitamin A and carotene was found in eggs laid by pullets fed alfalfa.

Wilson et al.(1936) obtained satisfactory growth when the diet of chicks was supplemented with 1,200 I.U. of vitamin per pound of feed. When supplied on an equivalent unit basis, carotene and vitamin A were equally utilized by chicks. Vitamin A stores in the liver was cumulative and increased with an increase in vitamin A of the diet.

Shellenberger et al.(1960) were able to raise newly hatched chicks, and to get good growth and egg production for a full year when carotene was the sole source of vitamin A in the feed, even when feeds were not entirely consumed until one month after mixing. In another study, Shellenberger et al.(1957) obtained 65 per cent

egg production on a hen-day basis and 90 per cent hatchability in Leghorn pullets, using alfalfa meal supplying 2,000 units of vitamin A per pound of ration. No antioxidant or protective measures were used, and the feeds were prepared once in 30 days. No deficiency symptoms were noted at any time during the experiment.

Zimmerman et al.(1961) observed that egg production was maintained at a significantly higher level in layers by 3,000 units per pound of feed of vitamin A activity from an alfalfa source as compared to 1,500 units. The pullets were depleted of their body stores of vitamin A before the experiment started. The provitamin A was the sole source of vitamin A activity in the eight-month experiment. There was no significant difference in feed conversion. No deficiency symptoms were observed at any time, hence they concluded that laying pullets can utilize carotene from alfalfa as their sole source of vitamin A.

Parrish and Sanford(1962) fed inbred-crossbred egg strain pullets basal diet supplemented with 2,000 or 3,000 units of vitamin A per pound as carotene of alfalfa or as 2,000 units of stabilized vitamin A. The alfalfa meal contained 270-580 units of vitamin A activity per gram. No significant differences were observed in egg weights, shell weights, per cent shell or Haugh unit scores. Egg production was higher in the group fed stabilized vitamin A. Feed conversion was also best for pullets receiving stabilized vitamin A.

The work of Skoglund et al.(1949) indicated that in laying pullets, in most cases carotene from dehydrated vegetable wastes in the form of concentrate was as efficient as vitamin A

esters from fish liver oil in maintaining egg production, feed consumption, and hatchability.

Shellenberger et al.(1960) reported that broiler strain chicks, depleted of their initial body vitamin A stores, gained three pounds or more between the second and ninth weeks, with a feed conversion of 2.1, using carotene of dehydrated alfalfa meal as the sole source of vitamin A.

Camp et al.(1955) reported greater response in growth when some or all of the carotene was replaced with vitamin A in the diet of growing chickens.

Parrish and Mitchell(1958) obtained a gain of 2.2 pounds and a feed conversion of 2.7 from the second through the ninth weeks by feeding 400 units of vitamin A per pound of feed to vitamin A depleted Hy-line male chicks.

From a dehydrated alfalfa source, Shellenberger et al. (1960) obtained gains in body weight and feed conversion in vitamin A depleted light strain Hy-line male chicks on a high energy feed containing 24 per cent protein, 1060 calories of productive energy, supplemented with 400 to 2,000 units of vitamin A per pound of feed from dehydrated alfalfa meal as the only source of vitamin A.

Though most of the scientists for example Conney et al. (1948) admit that dehydrated alfalfa above the five per cent level in mashes of either growing or laying chickens causes a depressing effect on growth and egg production, still there is a diversity of opinion by different workers. Lepkovsky et al. (1950) believed that fiber in alfalfa meal was not the offending

substance, but that dehydrated alfalfa meal contained a substance or substances, probably organic in nature, which was responsible for retarding the growth rate in chickens and the growth depression was associated with a decrease in feed intake.

Mussehl and co-workers(1950), using high quality alfalfa meal with high carotene and low fiber in chick diets, along with a 15 per cent protein diet, did not find any growth inhibition due to the alfalfa. High levels of alfalfa, up to 12 per cent, did not affect feed efficiency adversely. Later Kratzer and Davis (1957) reported there was no adverse effect on egg production, when up to 30 per cent alfalfa was included in the diet of turkeys.

Heywang(1950) demonstrated there was no depressed growth or egg production at a level of five per cent of alfalfa meal in the ration of White Leghorn pullets. It was further observed that dehydrated meal in excess of a 10 per cent level, lowered egg production appreciably. It was believed the inhibitory factor was some unidentified substance rather than fiber content.

Heywang and Bird(1953) noted adverse effect of saponin extract from alfalfa beyond 0.10 per cent in the growing chicken ration. It depressed growth rate, diet consumption and feed efficiency. This was in agreement with the work of Anderson (1957). The depressing effect of saponin at 0.30 per cent level was overcome by addition of one per cent cholesterol, or cotton seed oil and cholesterol, as reported by Peterson(1950).

Beta-carotene is efficiently utilized by chicks as stated by Capper et al.(1931). Rats rank first in efficiently converting

carotenoids into vitamin A; whereas, guinea pigs, rabbits, pigs and cattle do so to a lesser extent(Ahmad and Malik, 1933; Brockman and Tecklanburg 1933; Parrish et al.1951; and Moore, 1932). However, it is reported by Capper et al.(1931) that beta-carotene is used efficiently by chicks.

Matterson et al.(1950) and Thompson et al.(1950) demonstrated that carotene is converted to vitamin A in the wall of the small intestine; whereas, Worker(1956,1957) detected conversion of beta-carotene to vitamin A by a number of internal organs particularly the liver. Sibbald and Olsen(1958) and Sibbald and Hutcheson(1959) reported that when the duodenal loop of the chick was ligated, the conversion of carotene to vitamin A was prevented. On the other hand, Shellenberger(1961) observed a small amount of conversion of injected provitamin A to vitamin A, when vitamin A increments were injected into ligated poultry intestine sections.

Carotene when injected intravenously was removed rapidly from the blood stream of calves and chicks, and was detected from lungs and spleen as reported by Parrish(1954). This is not in agreement with the work of Berri(1955), who observed conversion of aqueous beta-carotene to vitamin A in vitamin A deficient chicks and rabbits, injected intravenously.

Balakhovskii et al.(1959) and Leitner(1951) observed vitamin A to maintain epithelial tissue of the body and Ewing(1947) detected insoluble salts of uric acid in ureters and kidney tubules in vitamin A deficient birds. Vitamin A deficient chicks were fed beta-carotene in oil by Cheng and Deuel(1948).

They found vitamin A in the intestinal wall after one hour and in the liver after three hours.

Wolf et al.(1958) demonstrated degeneration of adrenal cortex cells and depression in gluconeogensis due to impairment of gluco-corticoid hormone production in vitamin A deficient rats. Vitamin A regulates the catalytic activity of copper as reported by Balakhovskii and Brosdov(1959).

Singsen et al.(1955) prevented mortality from encephalomalacia when they added 0.025 per cent DPPD(diphenyl-phenylene-diamine) to the fish oil diet of chicks. Matterson et al.(1955) obtained two to five times higher vitamin A levels per gram of liver by including DPPD with the vitamin A in the ration. On the other hand, skin pigmentation decreased with the inclusion of DPPD in the broiler ration, as reported by Harms et al.(1958).

The use of furazolidone supplements in rations for growing, and laying birds has attracted considerable attention recently. Libby and Schaible(1955b) supplemented with 2.5 to 15 grams of furazolidone per ton of feed for growing chicks, and achieved increases in the rate of growth and feed efficiency.

According to Berg et al.(1955), penicillin, nitrofurazone, sulfaquinoxaline and nitrophenide were less effective than furazolidone in promoting growth of chicks when raised in old built-up litters.

Pope and Schaible(1958) demonstrated significant growth responses in chickens when the ration was supplemented with furazolidone and penicillin or furazolidone, penicillin and 3-nitro-4-hydroxphenyl-arsonic acid.

A study was undertaken by Mann(1958) to evaluate *in vitro* susceptibility of various species of 200 strains of *Salmonella* to furazolidone. Their results indicated this antimicrobial compound was effective in inhibiting the growth *in vitro* at a concentration of 12.5 to 25 micrograms of furazolidone per milliliter.

Fuller *et al.*(1958) observed the purified diet unsupplemented with vitamin B_6 resulted in increased mortality and depressed growth of chicks even though the diet contained various combinations of nitrofurazone, furazolidone and arsanilic acid. When vitamin B_6 was added to the diet, the combination of furazolidone and arsanilic acid resulted in normal growth of the chickens.

Francis and Shaffner(1956) used 0.0055 to 0.022 per cent furazolidone or nitrofurazone in the ration of chickens and laying pullets. Body weight was significantly reduced by 0.0165 or 0.022 per cent furazolidone. Little or no effect was observed on total egg production, hatchability or shell quality.

Thayer(1956) conducted experiments to determine the effect on rate of production, feed efficiency and mortality, when the diet of Single Comb White Leghorns was supplemented with furazolidone. It was observed that furazolidone fed birds did not maintain as high a rate of egg production as did control birds, feed efficacy was reduced, and mortality was reduced in the furazolidone-fed group.

Scott(1958) observed slight but consistant differences in egg production over the nonmedicated lots when Single Comb White Leghorn pullets were supplemented with 25 grams of

furazolidone per ton of feed. The furazolidone fed group showed a slight increase in egg production and feed efficiency, as well as laying comparatively larger eggs.

Smyth et al.(1959) found no significant effect on fertility or egg production using 0.011 per cent furazolidone in turkey rations; whereas, 0.022 per cent of the drug significantly depressed both fertility and hatchability. Vitamin E, at the level of 14 I.U. per pound, or d-alpha-tocopherol acetate, 34 I.U. per pound, significantly improved hatchibility. They concluded the effect of furazolidone on hatchability was related to the vitamin E level of the ration.

Moore et al.(1954) studied the effect of continuous feeding of furazolidone to turkeys during the breeding season. It was found that furazolidone had no effect on total egg production, fertility or hatchability.

Dean and Stephenson(1958) reported statistically significant improvement in egg production with the use of furazolidone, at levels of 12.5, 25 and 50 grams per ton, in a series of experiments with breeding hens; however, fertility was variable. The feed efficiency was increased by feeding furazolidone. In the case of White Leghorn caged layers, a combination of 15 grams of furazolidone and 90 grams of arsanilic acid per ton, resulted in better egg production than the combination of the two along with four grams of penicillin.

No significant effect on body weight, feed consumption or egg production was exhibited when Cooper(1956) fed furazolidone to White Leghorn pullets at the concentration of 0, 0.1, 0.15

and 0.20 per cent of the diet.

Working with Single Comb White Leghorn pullets and commercial hybrid pullets, Carlson(1958) found slightly greater egg production and feed conversion when the birds were fed furazolidone. In another experiment combining 25 grams per ton of furazolidone and nitrofurazone in an all-mash laying ration containing penicillin at 4 grams per ton resulted in improved egg production and feed efficiency.

Melloff et al.(1958) demonstrated that concentration of furazolidone of 100, 150 or 500 grams per ton of feed for laying hens resulted in no significant concentration of the drug in eggs, ova or tissue. The egg production, quality and color of egg shell, and color of egg yolk were not affected aversely.

Parrish and Sanford(1960) exploring the effect of feeding increasing levels of furazolidone in the diet of laying hens found decreased egg weight and improved feed efficiency, whereas, egg production increased slightly.

A study was conducted by Zimmerman et al.(1961) to determine the effect of feeding furazolidone on utilization of carotene by confinement-reared inbred-crossbred floor pen layers. Dehydrated alfalfa meal was added to basal diet at the rate of 1,500 or 3,000 units of vitamin A activity per pound of feed. Furazolidone was added at levels of 0, 25, 50 and 125 grams per ton of feed for each level of vitamin A. A significantly higher rate of egg production was noted when 3,000 units of vitamin A activity per pound of feed was added as compared to 1,500 units.

A higher rate of production was also maintained when 25, 50

and 125 grams of furazolidone per ton of feed and 1,500 units of vitamin A activity or 50 and 125 grams of furazolidone per ton of feed was fed with the 3,000 units of vitamin A activity. Use of furazolidone improved feed conversion; however, egg size and yolk size were reduced by the drug, with the greatest effect noted at the highest level of drug. Mortality was low and not affected by the levels of vitamin A or furazolidone. The interaction between furazolidone and vitamin A was limited and in most cases questionable. They finally concluded that the laying hen can utilize carotene from alfalfa as its sole source of vitamin A.

MATERIALS AND METHODS

This experiment was conducted in the Poultry Nutrition Laboratory at the Kansas State University Poultry Farm for 21-14 day periods. The birds used for the experiment were day-old Hy-line 934-H pullets obtained from Combs Poultry Farm, Inc., Sedgwick, Kansas. They were reared under normal poultry husbandry practices at the Kansas State University poultry farm. They were brooded for the first three weeks in a chick battery-brooder of the conventional type, with electric heating units and thermostatic control. From the third to the eighth week, they were brooded under floor pen management. Heat was supplied by electric hovers, and wood shavings were used as litter. Fresh water and granule feeds were kept before the birds at all times. From the eighth week till sexual maturity, they were range reared. The birds were protected against contagious diseases by preventive vaccination; intranasal

vaccination for Newcastle disease and bronchitis at one day of age, fowl pox vaccination at 12 weeks and wing web vaccination for Newcastle disease at 14 weeks of age.

All the pullets to be used for the experiment were wing banded for identification and placed in the experimental house at 22 weeks of age. They were randomized into six lots of six pullets each in two identical Bussey Hen Batteries. The pullets remained in the batteries four weeks before the experiment began to allow adjustment to the new environment, and were fed carotenoid-free ration to deplete body stores of vitamin A before starting on the experimental ration. During the entire experimental period, the pullets received vitamin A- and carotene-free basal ration supplemented with 3,000 I.U. of provitamin A activity per pound of diet, from dehydrated alfalfa meal, for lots 1 to 4, and the same units of stabilized vitamin A for lots 5 and 6. Furazolidone was added at levels of 0, 25, 50 and 100 grams per ton, respectively, for lots receiving provitamin A and 0 and 100 grams per ton for lots supplemented with stabilized vitamin A.

Individual body weights of pullets were taken initially, and at the end of the experimental period (December 8, 1961 and September 28, 1962).

The composition of the carotenoid-free basal diet used for the birds is detailed in Table 1.

The rations were mixed in the feed building of the Kansas State University Poultry Farm. The sorghum grain was screened in order to remove any yellow corn before the grain was ground

Table 1. Composition of the basal diet used in the experiment.

Ingredients	Amount per 100 pounds
Sorghum grain, ground	73.5 pounds
Wheat standard middlings	4.0 "
Soybean oil meal (44% solvent extracted)	13.0 "
Fish meal (Menhaden)	1.5 "
Brewer's dried yeast	1.5 "
Salt (NaCl)[1]	0.5 "
Ground limestone (Calcium carbonate)[1]	4.0 "
Steamed bone meal[1]	2.0 "
Total	100.0 "
Added per 100 pounds of ration:	
$MnSO_4$[1]	23 grams
Vitamin K (Klotogen F;8gm./lb)[2]	4.8 "
D-L Methionine[2]	46.0 "
Vitamin D_3 (15,000 ICU/lb.)[2]	5.0 "
Proferm$_{12}$(R) (Vitamin B_{12})[2]	19.0 "
*Merok 58-A(R) (Vitamin pre-mix)[2]	23.0 "
Choline chloride (25% mix)[2]	88.0 "

1 = Mineral pre-mix

2 = Additive pre-mix

(R)= Registered trade-mark

* Supplies: a. 3,680 mg. of D-pantothenic acid per pound of suppl.

b. 6,000 mg. of niacin per pound of suppl.

c. 20,000 mg. of choline chloride per pound of suppl.

d. 2,000 mg. of riboflavin per pound of suppl.

in the hammer mill. The macro-ingredients, such as ground sorghum grain, wheat standard middling and soybean oil meal, were weighed accurately on a large Toledo balance; micro-ingredients such as manganese sulfate, vitamin K, D-L methionine etc. were weighed on a computagram balance.

The mineral and vitamin pre-mixes were prepared separately in an electric Hobart Mixer for five minutes in a carrier of about 15 pounds ground sorghum grain in order to prevent vitamins being oxidized by ferrous salt. For the second time the pre-mixes were blended separately in 75 pounds of ground sorghum grain in a 100 pound horizontal mixer for five minutes and finally the entire basal ration was mixed in a separate 1,000 pound capacity horizontal mixer for five minutes. The basal ration was then distributed into 100 pound burlap bags.

The basal ration was prepared fresh once in three weeks throughout the experimental period in order to prevent deterioration due to long storage. The supplements were mixed with the basal ration once a week and unused feed was weighed back and discarded at the end of each two week period.

The experimental design used is shown in Table 2. Fifteen pounds of the basal diet was weighed out into each of six separate feed cans, labled for each lot of birds. The supplements, namely stabilized vitamin A and furazolidone, were weighed on a double pan beam balance. The dehydrated alfalfa meal used for the experiment was procured locally weighed and analyzed monthly by A.O.A.C.[1] method to determine vitamin A activity before using. It contained 17 per cent protein.

1. Association of Official Agricultural Chemists. Methods of analysis, carotene, 9th ed., pp. 654-655. 1960.

Table 2. Experimental design to study effects of feeding provitamin A, stabilized vitamin A and furazolidone in cage layers.

Lot	Diet
1.	Basal + 3,000 units of provitamin A per pound of feed + 0 grams of furazolidone[1] per ton of feed.
2.	Basal + 3,000 units of provitamin A per pound of feed + 25 grams of furazolidone per ton of feed.
3.	Basal + 3,000 units of provitamin A per pound of feed + 50 grams of furazolidone per ton of feed.
4.	Basal + 3,000 units of provitamin A per pound of feed + 100 grams of furazolidone per ton of feed.
5.	Basal + 3,000 units of stabilized vitamin A per pound of feed + 0 grams of furazolidone per ton of feed.
6.	Basal + 3,000 units of stabilized vitamin A per pound of feed + 100 grams of furazolidone per ton of feed.

[1]Manufacturer's recommended level: 25 grams of furazolidone per ton of feed.

Some of the basal diet of each individual lot was transferred to a small electric Hobart mixer. The supplement or supplements were added, the rest of the basal diet was poured in, and the feed mixed for five minutes. The experimental diet was transferred to the respective feed cans, to be fed ad lib. The feed consumed for the period was arrived at by deducting the quantity discarded from the total feed weighed out for the two week period.

The birds were supplied water ad lib. Ventilation was provided by a forced air draft at all times. Fourteen hours of artifical light per day was supplied during the experiment by three rows of five 60-watt electric bulbs hanging from the ceiling

on either side of the batteries. The lights were connected to a time clock and supplied light from 6 a.m. to 8 p.m. daily.

All records of the experiment were calculated and maintained on a two week period basis. The criteria used for the experiment were egg weight, yolk weight, shell weight, per cent yolk, per cent shell, Haugh units, and observed abnormalities such as blood spots and streaks and meat spots. In addition, rate of production, feed utilization and mortality were taken into account.

All eggs were collected from each lot for three consecutive days at the end of each two week period, in order to determine external and internal quality. For this purpose individual eggs were numbered, dated, weighed on gram-atic balance the following day and kept in the cooler at a temperature of about 55°F., with a relative humidity of about 75 per cent, until three days collections were made. At the end of this period, each egg was broken onto a glass plate and quality determined by using AMS[1] method. The height of the thick albumen was measured with a micrometer. Next the egg yolk was taken out, the chalazae carefully separated, without rupturing the vitelline membrane, and the yolk weighed on the gram-atic balance.

The egg shell was then washed clean with water in order to remove any albumen. The shells were placed in a thermostatically controlled hot air oven at a temperature of 100 degrees centigrade for 24 hours to remove the moisture. The shells were then

1. U.S. Department of Agric. Mkt. Serv. Poultry Division AMS No. 246.

taken out one day's collection at a time, cooled for five minutes, and weighed individually on a gram-atic balance to four decimal places. Both per cent shell and per cent yolk were calculated by dividing the shell weight and yolk weight figures, respectively, by the egg weight. The Haugh score was determined with a Haugh unit calculater where a pointer is adjusted to the weight of the egg in grams and the slide scale adjusted to the albumen height; the reading was taken at a point where the middle point of the slide scale bisected the Haugh unit score of the calculater. All statistical analyses applied are described by Snedecor (1956).

RESULTS AND DISCUSSION

Egg Production. The per cent egg production was calculated on a hen-day basis for 21-14 day periods. The analysis of variance of per cent production was run on the mean number of eggs laid by all six lots(Table 3). There were significant differences in treatments and periods. For all lots, the per cent production varied through the period. It is believed this variation was due to several factors, of which, heredity is said to be responsible for about 20-34 per cent of the variation found in egg production(Shaffner 1946). At the beginning of the experiment, the egg production ranged from 82 to 90 per cent, but there was a gradual decline in egg production so that at the end of the experimental period the egg production ranged from 46 to 65 per cent in the furazolidone fed lots. It appeared furazolidone supplementation did not maintain a high rate of production. This is in agreement with the work of Francis and Shaffner(1956), Thayer(1956), and Cooper(1956).

Table 3. Analysis of variance of per cent egg production for 21-14 day periods.

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-ratio
Treatment	5	1,555.72	311.14	12.04**
Periods	20	14,617.45	730.87	28.28**
Treatment x periods	100	2,584.22	25.84	
Total	125			

** Significant <.01

The mean per cent production of eggs was 75.11, 69.83, 74.96, 68.53, 67.23 and 76.02 for lots 1,2,3,4,5 and 6, respectively. (Appendix Table 1.). When l.s.d. was applied to the means of the per cent production for various lots, the means could be arranged in the following order:

Lot No.:	4	2	3	1
Means:	68.53	69.83	74.96	75.11

Lot No.:	5	6
Means:	67.23	76.02

Lot No.:	5	1
Means:	67.23	75.11

Lot No.:	4	6
Means:	68.53	76.02

Differences in means underscored were non significant.

Furazolidone at the high level of 100 grams per ton of feed in lot 4 and 50 grams in lot 3(both lots having 3,000 units of provitamin A) resulted in decreased egg production when compared to control lot 1. In the case of lot 2, which contained

the normal recommended level of furazolidone (25 grams per ton of feed), there was also a decrease in production.

When per cent production for lots 5 and 6 was considered, an increase was found in per cent production of lot 6 over that of 5, the mean average production for lots 5 and 6 being 67.23 and 76.02 per cent, respectively. Lots 5 and 6, both received 3,000 units of stabilized vitamin A with 0 and 100 grams of furazolidone per ton of feed. The work of Scott(1958), Carlson(1958), Zimmerman et al.(1961) supported that furazolidone causes an increase in egg production. The percentage production of lot 6 was greater than that of lots 1,2,3,4 and 5. In the case of lots 1 and 5, where sources of 3,000 units of vitamin A were alfalfa and stabilized vitamin A, respectively, the same trend in per cent production was not evident. On the contrary, there was a greater per cent production from lot 1 than from lot 5. The mean average per cent of lots 1 and 5 was 75.11 and 67.23, respectively.

Feed Efficiency. The analysis of variance(Table 4) of feed efficiency(Pounds of feed consumed to produce a dozen eggs) was calculated for 21-14 day periods, and then grouped into three major 14 week periods(Table 5). This was done to observe differences in feed efficency in the initial, middle and end of the experimental period. The feed efficiency was reduced through 0-14, 15-28 and 29-42 week periods.

There were significant differences between the treatment and the periods. The egg production and feed efficiency were inversely related. The l.s.d. run on the mean of the feed

consumed per dozen eggs for six lots is indicated below:

Lot No.:	1	3	4	2
Means:	3.65	3.83	3.93	3.96

Lot No.:	6	5
Means:	3.65	4.24

Lot No.:	1	5
Means:	3.65	4.24

Lot No.:	6	4
Means:	3.65	3.93

Differences in means underscored were non significant.

It was observed there was a non significant difference in feed efficiency among lots 2,3 and 4, where furazolidone was added at levels of 25 grams, 50 grams and 100 grams, respectively. Lot 1(without furazolidone) revealed significantly better feed efficiency as compared with lots 2,3 and 4. This is in agreement with the work of Thayer(1956) and Cooper(1956), but differs from results obtained by Scott(1958), Carlson(1958), Dean and Stephenson(1958) and Parrish and Sanford(1960).

Differences observed in feed efficiency between the means of lots 6 and 5 were highly significant. Feed efficiency for lot 1 was 3.65 as compared with 4.24 pounds of feed per dozen egg in lot 5. The supplementation of 100 grams of furazolidone in lot 6 (3,000 units of stabilized vitamin A) had a significant effect in increasing the feed efficiency as compared with lot 4(receiving 3,000 units of provitamin A).

Table 4. Analysis of variance of feed efficiency for 3-14 weeks period.

Source of variation:	Degrees of: freedom :	Sum of: square:	Mean : square:	F-ratio
Treatment	5	0.75	0.15	3.49 **
Periods	2	3.06	1.53	35.58 **
Treatment x periods	10	0.4286	0.043	
Total	17			

** Significant $< .01$

Table 5. Feed efficiency (lbs.feed/doz. eggs) for 3-14 week periods for the six lots of experiment.

Lots	0-14 weeks	15-28 weeks	29-42 weeks	Average
1	3.43	3.63	3.89	3.65
2	3.44	3.69	4.74	3.96
3	3.43	3.70	4.36	3.83
4	3.41	3.90	4.47	3.93
5	3.61	4.03	5.09	4.24
6	3.36	3.54	4.04	3.65

Egg Weight. The analysis of variance of egg weight (Table 6) was run on the mean number of eggs laid by all six lots. Based on 18-14 day periods, there were significant differences in the treatment and periods; however, interaction was non significant. Addition of furazolidone at 25, 50 and 100 grams per ton, respectively, in lots 2,3 and 4, receiving 3,000 units of provitamin A from dehydrated alfalfa source, reduced egg weight. When the l.s.d. was applied to the means for egg weight, the

means could be arranged in the following order.

Lot No.:	4	3	2	1
Means:	57.46	57.76	59.03	60.72

Lot No.:	6	5
Means:	58.20	61.77

Lot No.:	1	5
Means:	60.72	61.77

Lot No.:	4	6
Means:	57.46	58.20

Differences in means underscored were non significant.

The mean egg weight at the recommended level of furazolidone (25 gms/ton) was 59.03 grams and at the highest furazolidone level was 57.46 grams in provitamin fed lots. The reduction in egg weight was statistically significant among lots, except lots 3 and 4, although the mean egg weights for these two lots were 57.76 and 57.46 grams, respectively.

The addition of furazolidone at 100 grams per ton in the diet of lot 6(receiving 3,000 units of stabilized vitamin A) resulted in a statistically significant decrease in egg weight when compared to the 0 drug supplement(lot 5) however, it was significantly higher when compared to lot 4.

The reduction in egg size due to effect of furazolidone is in agreement with the work of Zimmerman et al.(1961), who observed that furazolidone at the rate of 25, 50 or 125 grams per ton of feed, of floor pen inbred-crossbred layers, reduced egg size at 1,500 and 3,000 units of vitamin A activity per pound of feed. Reduction in egg weight is correlated with yolk weight (Jull 1924). Scott(1958), however, observed comparatively larger eggs with furazolidone fed hens.

Table 6. Analysis of variance of egg weights.

Source of variation:	Degrees of: freedom :	Sum of : squares:	Mean : square:	F-ratio
Treatment	5	811.982	162.40	89.7 **
Periods	17	538.789	31.69	17.5 **
Treatment x periods	85	168.283	1.98	1.09 n.s.
Error	216	391.889	1.81	
Total	323	1910.943		

** Significant <.01
n.s. Non significant

Yolk Weight. The analysis of variance of yolk weight (Table 7) was run on the mean number of yolk from all the six lots. There were significant differences in treatments, periods and interaction. Supplementation of furazolidone at 25, 50 and 100 grams per ton of feed significantly reduced the yolk weight in lots 2,3, and 4. When l.s.d. was applied to the means, the means could be arranged in the following order.

Lot No.:	4	3	2	1
Means:	16.74	17.21	17.52	17.94

Lot No.:	6	5
Means:	17.02	17.95

Lot No.:	1	5
Means:	17.94	17.95

Lot No.:	4	6
Means:	16.74	17.02

Differences in means underscored were non significant.

The decrease in yolk weight resulted from the gradual increase in the level of the drug, the maximum decrease being noted in lot 4(receiving 100 grams of the drug). This followed

the same pattern as in the case of egg weight, the mean yolk weight for lot 1(with 0 supplementation of drug) being 17.94 grams, followed by 17.52, 17.21 and 16.74 grams, respectively, for lots 2, 3, and 4.

Yolk weight was also significantly reduced by 100 grams of furazolidone per ton of feed in lot 6(receiving 3,000 units of stabilized vitamin A) when compared to lot 5(with 0 supplementation of the drug). However, the yolk weight was significantly higher when compared to lot 4(receiving the same level of the drug with provitamin A). The reduction in yolk weight, with the increase in the level of furazolidone, is in agreement with the results obtained by Zimmerman et al.(1961). It is believed by Warren and Conrad(1939) that premature ovulation is the cause of reduction in the yolk weight.

The mean yolk weight of lots 1 and 5(receiving 3,000 units of provitamin A and stabilized vitamin A, respectively) were 17.94 and 17.95 grams, respectively.

Table 7. Analysis of variance of yolk weights.

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-ratio
Treatment	5	66.0904	13.22	41.31 **
Periods	17	184.3732	10.85	33.91 **
Treatment x Periods	85	39.2006	.46	1.44 **
Error	216	69.4138	.32	
Total	323			

** Significant < .01

Per Cent Yolk. An analysis of variance of the mean per cent yolk(Table 8) indicated significant differences in treatment and periods but interaction was non significant. Non significant increase in per cent yolk resulted, when the diet contained 25 or 50 grams furazolidone per ton of feed in the lots receiving provitamin A. However, there was a significant decrease in per cent yolk for lot 4(receiving maximum drug concentration). When l.s.d. was applied to the means, they could be arranged in the following order

Lot No.:	4	1	2	3
Means:	29.08	29.54	29.56	29.72

Lot No.:	5	6
Means:	28.92	29.20

Lot No.:	5	1
Means:	28.92	29.54

Lot No.:	4	6
Means:	29.08	29.20

Differences in means underscored were non significant.

Birds fed the diet containing provitamin A showed a significant increase in per cent yolk when compared to stabilized vitamin A fed lots. However, supplementation of furazolidone, 100 grams per ton of diet, in lot 4 resulted in a significant decrease in per cent yolk. This decrease was not statistically significant when compared to the per cent yolk of lot 6(receiving the same level of the drug with the diet containing stabilized vitamin A).

Table 8. Analysis of variance of per cent yolk.

Source of variation:	Degrees of: freedom :	Sum of: square:	Mean : square:	F-ratio
Treatment	5	26.9429	5.39	7.93 **
Periods	17	238.2920	14.01	20.60 **
Treatment x Periods	85	52.0185	0.61	0.89 n.s.
Error	216	147.0394	0.68	
Total	323			

** Significant < .01
n.s. Non significant

Although there was a decrease in per cent yolk in lot 6, with the drug, it was non significant when compared to lot 5, without the drug. Both lots 5 and 6 received 3,000 units of stabilized vitamin A.

Lot 1 receiving 3,000 units of vitamin A from dehydrated alfalfa meal resulted in a significant increase in per cent yolk over lot 5 which received equal units of stabilized vitamin A. The per cent yolk was 29.54 and 28.92, respectively, for lots 1 and 5.

Shell Weight. An analysis of variance of the mean shell weight is presented in Table 9. There were significant differances in treatment and interaction. However, there was non significant difference in periods. Furazolidone resulted in a gradually decreasing shell weight from birds in lots 2, 3 and 4. The mean shell weights were 5.0063, 4.7679 and 4.7009 grams at 25, 50 and 100 gram drug level in lots 2,3 and 4, respectively. When l.s.d. was applied to the means, the means

could be arranged in the following order:

Lot No.:	4	3	2	1
Means:	4.7009	4.7679	5.0063	5.0632

Lot No.:	6	5
Means:	4.8131	5.2334

Lot No.:	1	5
Means:	5.0632	5.2334

Lot No.:	4	6
Means:	4.7009	4.8131

Differences in means underscored were non significant.

Table 9. Analysis of variance of shell weight.

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-ratio
Treatment	5	11.2362	2.2472	5.5 **
Periods	17	3.8979	0.2293	0.57 n.s.
Treatment x Periods	85	4.6455	0.5465	1.4 **
Error	216	8.7147	0.4035	
Total	323			

** Significant <.01
n.s. Non significant

The decrease in shell weight with the increase in drug level is in agreement with the work of Zimmerman, et al.(1961), who reported that at the level of 3,000 units of vitamin A activity the 125 grams of furazolidone significantly reduced shell weight below that for all other levels of the drug. Statistically significant reduction in shell weight also resulted, in our experiment when lot 1 is compared with lots 3 and 4. However, differences in shell weight between lots 1 and 2, 2 and 3, and 3 and 4 were non significant.

Lots 5 and 6 revealed statistically significant decreases in shell weight. The addition of 100 grams of furazolidone to lot 6 resulted in decreased shell weight. The mean shell weight being 4.8131 grams as compared to 5.2334 grams for lot 5, which had 0 supplementation of the drug.

Although there was a slight difference in shell weight between lots 1 and 5, this was statistically non significant. Both these lots received 0 supplementation of the drug, but contained 3,000 units of provitamin A and stabilized vitamin A, respectively.

The analysis of variance further indicated a non significant difference in shell weight between lots 4 and 6(both supplemented with the highest drug level of 100 grams per ton), although the shell weight was reduced comparatively more in lot 4.

Per cent Shell. Furazolidone at the 25 grams level significantly increased per cent shell in lot 2 when compared to the control, lot 1. This is in agreement with the work of Zimmerman et al.(1961) who noted per cent shell was significantly increased when using furazolidone at the 125 gram level with floor pen layers. However, per cent shell showed a non significant decline in lots 3 and 4 when compared to the control, lot 1. The analysis of variance for per cent shell is presented in Table 10. There were significant differences among the treatments, periods and interactions.

Table 10. Analysis of variance of per cent shell.

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-ratio
Treatment	5	4.4622	0.89	8.9 **
Periods	17	15.2449	0.90	9.0 **
Treatment x Periods	85	12.6717	0.15	1.5 **
Error	216	22.0681	0.10	
Total	323			

** Significant $<.01$

When l.s.d. was applied to the means, the means could be arranged in the following order:

Lot No.:	4	3	1	2
Means:	8.19	8.26	8.35	8.51

Lot No.:	6	5
Means:	8.27	8.49

Lot No.:	1	5
Means:	8.35	8.49

Lot No.	4	6
Means:	8.19	8.27

Differences in means underscored were non significant.

Per cent shell of eggs produced by birds in lots fed stabilized vitamin A averaged significant increased when compared to provitamin A fed lots, but the difference between lots 4 and 6 was not significant. Furthermore, lots 1 and 5, having 0 level of the drug, showed a significant difference in per cent shell, with lot 5 being greater.

Haugh units. There were significant differences in treatment and periods; whereas, interaction was non significant. Haugh

units increased when furazolidone was added to lots 2, 3 and 4. The highest Haugh unit score was recorded for lot 2. Lot 5 did not differ significantly from lot 1. When l.s.d. was applied to the means, the means could be arranged in the following order.

Lot No.:	1	3	4	2
Means:	74.30	75.96	75.98	77.31

Lot No.:	6	5
Means:	74.22	74.26

Lot No.:	5	1
Means:	74.26	74.30

Lot No.:	6	4
Means:	74.22	75.98

Differences in means underscored were non significant.

Haugh unit scores for lots 6 and 4 were significantly different. All the eggs were AA grade, according to USDA standard. This was in agreement with the work of Zimmerman et al. 1961.

The analysis of variance of Haugh units is presented in Table 11.

Table 11. Analysis of variance of Haugh Units.

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-ratio
Treatment	5	443	88.6	6.9 **
Periods	17	5967	351.0	27.2 **
Treatment x Periods	85	1080	12.7	0.98 n.s.
Error	216	2785	12.9	
Total	323			

** < .01
n.s. Non significant

Inedible eggs due to blood spots and blood streaks. Records of observed blood spots and blood streaks were kept during determining interior quality of broken out eggs. Treatments with furazolidone did not appear to exert an effect on blood spots and or blood streaks. Eggs of lots 1 and 5 with 0 level of drug showed a few blood spots, and blood streaks when compared to rest of the furazolidone treated lots (appendix Table 2). A total number of 7 and 5 eggs, respectively, in only provitamin A and stabilized vitamin A fed lots(Lots 1 and 5) showed blood spots and blood streaks. Zimmerman et al. (1961), Bearse et al.(1953) reported reduction in blood spots with the increase in the vitamin A level of the diet. In our experiment also, provitamin A or stabilized vitamin A at the level of 3,000 units per pound of diet showed negligible inedible eggs due to blood spots and blood streaks.

Mortality. There were a total of three mortality in the whole experimental period due to avian leucosis and other causes. Mortality appeared only in furazolidone fed group of birds, lots 2, 3 and 4 loosing one bird from each lot(Appendix Table 3). Stiles(1962) fed furazolidone at the level of 25 grams per ton of feed to layers and obtained a non significant effect on mortality when compared to the non treated control group. On the other hand, Thayer(1956) reported reduced mortality in the furazolidone-fed group of birds.

Body Weight. Body weight records were kept on all birds' Lots 4, 5 and 6 resulted equally in heaviest body weight

(Appendix Table 4). The body weight of birds fed provitamin A (lot 1) with 0 drug supplementation, was lower than that of lot 5 receiving stabilized vitamin A with 0 drug supplementation. Furazolidone at levels of 50 and 100 grams per ton of feed resulted in increased body weight as compared with the 25 gram level. However, lot 5, having 3,000 units of stabilized vitamin A with 0 drug supplementation, showed equivalent gain in body weight when compared with lots 4 and 6, having 100 grams of drug concentration. The body weight for lot 1 was the minimum of all the lots.

At the end of the experiment, four birds from each lot were sacrificed and determination made for the vitamin A content of egg yolk and liver. Provitamin A from dehydrated alfalfa meal resulted in storage of 96 to 231 mmg of vitamin A per liver, whereas, stabilized vitamin A had a range of 3,463 to 4,277 mmg of vitamin A per liver. This increase in liver storage of vitamin A in birds fed the stabilized vitamin A was highly significant over those fed dehydrated alfalfa meal. However, non significant differences in amount of vitamin A per egg yolk were found between groups that received provitamin A and stabilized vitamin A. The level of furazolidone did not appear to have a significant effect on liver or egg vitamin A content. The data for the analysis of variance of liver weight, liver vitamin A, yolk weight and yolk vitamin A are presented in Appendix Table 5.

SUMMARY AND CONCLUSION

An experiment was conducted to study effects of feeding provitamin A, stabilized vitamin A, and furazolidone on the performance of cage layers. The experiment involved 21-14 day periods. Hy-line 934-H pullets were randomized, at 22 weeks of age, into six lots of six pullets each in two identical Bussey Hen Batteries. The birds were fed a vitamin A- and carotene-free basal ration supplemented with 3,000 I.U. of provitamin A per pound of diet, from dehydrated alfalfa meal, for lots 1 to 4, and the same units of stabilized vitamin A for lots 5 and 6.

Furazolidone was added at levels of 0, 25, 50 and 100 grams per ton, respectively, for lots receiving provitamin A and 0 and 100 grams per ton for lots supplemented with stabilized vitamin A. Factors used as criteria of measurement were: egg weight, yolk weight, shell weight, per cent yolk, per cent shell, Haugh units, per cent egg production and feed efficiency. In addition, observations were made for blood spots and blood streaks. Body weight was taken initially and at the close of the experimental period. Mortality was also recorded. All records were maintained for each two-week period.

Under the conditions of this experiment, the following conclusions were drawn:

1. Levels of 3,000 I.U. of either provitamin A from dehydrated alfalfa meal or stabilized vitamin A, per pound of diet were equally effective to support satisfactory egg

production and maintain health of cage layers.

2. Pullets receiving 3,000 units of provitamin A per pound of diet, supplied by dehydrated alfalfa meal, averaged 7.88 per cent higher egg production than those receiving the same units of vitamin A(without the drug).

3. Combination of 100 grams of furazolidone with 3,000 units of stabilized vitamin A per pound of feed significantly increased egg production and ranked superior to all other treatments.

4. Increasing levels of furazolidone reduced egg weight, yolk weight and shell weight. The yolk weight being significantly reduced.

5. Use of furazolidone in provitamin A fed lots appeared to reduce egg production and feed conversion.

6. Haugh unit scores appeared to be increased and feed conversion reduced by supplementation of furazolidone in provitamin A fed lots.

7. Supplementation of furazolidone in provitamin A lots resulted in weight gains higher than the control except lot 2; however, there was no difference in gain in average body weights in the stabilized vitamin A fed lots.

8. There were a few blood spots and blood streaks in the total eggs produced.

9. Neither the source of vitamin A nor the drug appeared to have any effect on mortality.

10. There was a highly significant increase in liver storage in stabilized vitamin A groups over those fed dehydrated

alfalfa meal; however, a non significant difference in amount of vitamin A per egg yolk was found between groups receiving provitamin A and stabilized vitamin A.

11. The level of furazolidone did not appear to have a significant effect on liver or egg vitamin A content.

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APPENDIX

Appendix Table 1. Per cent egg production on hen days basis

Periods (14 days each)	Lot Nos. 1	2	3	4	5	6
1	84.52	94.05	82.14	88.10	78.57	90.48
2	78.57	83.23	84.52	85.71	83.33	89.29
3	83.33	84.52	85.71	79.76	82.14	84.52
4.	79.76	85.71	85.71	83.33	83.33	91.67
5	80.95	78.57	86.90	82.14	82.14	85.71
6	80.95	79.76	82.14	80.95	83.33	84.52
7	76.19	75.00	85.71	77.38	78.57	83.33
8	78.57	77.38	84.52	80.95	71.43	84.52
9	79.76	75.00	82.14	80.95	75.00	83.33
10	76.19	66.67	77.63	75.00	72.62	80.95
11	75.00	77.50	77.14	61.91	70.24	80.95
12	76.19	61.97	80.00	61.90	70.24	77.38
13	76.19	65.71	72.86	64.29	66.67	72.62
14	66.67	64.29	71.43	63.10	67.86	67.86
15	70.24	71.43	67.14	58.33	60.71	75.00
16	69.05	65.71	67.14	59.52	60.71	64.29
17	73.81	62.86	67.14	46.43	52.38	60.71
18	67.86	61.43	58.57	55.95	42.86	61.90
19	67.86	42.86	51.43	52.00	41.67	59.52
20	70.24	41.43	60.00	44.28	41.66	61.90
21	65.48	51.43	64.29	57.14	46.43	55.95
Average	75.11	69.33	74.96	68.53	67.23	76.02

Appendix Table 2. Number of inedible eggs due to blood spots and blood streaks.

Dietary Treatment	0-12 weeks	13-14 weeks	25-36 weeks	Treatment total
1	2	2	3	7
2	7	4	2	13
3	9	6	5	20
4	7	6	5	18
5	1	1	3	5
6	2	3	1	6
Period total	28	22	19	69

Appendix Table 3. Number of bird dead.

Dietary Treatments	0-14 weeks	15-28 weeks	29-42 weeks	Treatment total
1	-	-	-	-
2	1	-	-	1
3	1	-	-	1
4	-	1	-	1
5	-	-	-	-
6	-	-	-	-
Period total	2	1	-	3

Appendix Table 4. Record of average body weight(lbs.) for lots. initial wt. final wt. gain in wt.

Dietary Treatments	0 weeks	42 weeks	0-42 weeks
1	3.6	3.8	0.2
2	3.7	3.7	0.0
3	3.4	3.7	0.3
4	3.7	4.3	0.6
5	3.5	4.1	0.6
6	3.6	4.2	0.6

Appendix Table 5. Analysis of variance for liver weight, liver vitamin A units/liver, yolk weight and yolk vitamin units/yolk.

Liver weight.

	d.f.	s.s.	m.s.	F
Treatment	5	212.6	42.5	0.57 n.s.
Error	18	1,335.1	74.2	
Total	23			

n.s. Non significant

Liver vitamin A units/liver.

	d.f.	s.s.	m.s.	F
Treatment	5	74,279.679	14,855.936	9.62 **
Error	18	27,787,564	1,543.754	
Total	23			

L.S.D. 1.818

** < .01

Lot 3	Lot 1	Lot 4	Lot 2	Lot 5	Lot 6
384	624	833	922	13,853	17,108

(Lots underscored with the same line do not differ significantly)

Yolk weight.

	d.f.	s.s.	m.s.	F
Treatment	5	25.31	5.062	1.049 n.s.
Error	18	86.84	4.824	
Total	23			

n.s. Non significant

Yolk vitamin A units/yolk.

	d.f.	s.s.	m.s.	F
Treatment	5	2,705	541.0	0.31 n.s.
Error	18	11,089	1,727.2	
Total	23			

n.s. Non significant

EFFECTS OF FEEDING PROVITAMIN A, STABILIZED VITAMIN A, AND FURALTADONE ON PRODUCTION AND QUALITY OF EGGS

by

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An experiment was conducted at the Kansas State University Poultry Farm to test the performance of cage layers fed a diet supplemented with provitamin A, stabilized vitamin A and furazolidone. Hy-line 934-H pullets were randomized into six lots of six birds each.

Birds in lots 1 to 4 were fed a vitamin A and carotene-free basal ration supplemented with 3,000 I.U. of provitamin A per pound of diet, from dehydrated alfalfa meal, and birds in lots 5 and 6 were fed the same number of units of stabilized vitamin A. Furazolidone was added at levels of 0, 25, 50 and 100 grams per ton, respectively, for lots receiving provitamin A and 0 and 100 grams per ton for lots supplemented with stabilized vitamin A.

All records were maintained for each two-week period until termination of the experiment after 42 weeks. The conclusions drawn under the conditions of this experiment are as follows:

Levels of 3,000 I.U. of either provitamin A or stabilized vitamin A per pound of diet were equally effective for optimum egg production and maintenance of health; however, pullets receiving 3,000 I.U. of provitamin A averaged 7.88 per cent higher egg production. Feed conversion ratios were 3.65 and 4.24, respectively. A combination of 100 grams of furazolidone with 3,000 I.U. of stabilized vitamin supplementation per pound of basal diet gave best results for egg production. On the other hand, use of furazolidone in provitamin A fed lots appeared to reduce egg production and feed conversion.

Egg weight, yolk weight and shell weights were reduced by

supplementing the basal diet with furazolidone, with the greatest effect noted at the highest level of drug. Per cent yolk and per cent shell were also reduced at the highest level of drug with the provitamin fed groups. All eggs were graded AA for internal quality(Haugh units). Supplementation of furazolidone, in provitamin A lots, resulted in higher body weight gains than the control except lot 2. However, there was no difference in gain in average body weight in the stabilized vitamin A fed lots. Though the incidence of blood spots and blood streaks were few, furazolidone did not appear to reduce their number. Neither the source of the vitamin A nor the drug appeared to have any effect on mortality.

There was a highly significant increase in liver vitamin A storage in the stabilized vitamin A lot as compared with those fed dehydrated alfalfa meal. Amounts of vitamin A per egg yolk was non significant. The level of furazolidone did not appear to have a significant effect on liver or egg vitamin A content.