VITAMIN A STORAGE IN PEN-REARED BOB-WHITE QUAIL

GLENN JONES and RUBLE LANGSTON, University of Oklahoma, Norman

The Bob-White Quail (*Colinus virginianus*) is generally recognized as Oklahoma's number one game species and as such is deserving of the time and money spent in investigations on its behalf. There has been considerable research done on bob-white quail management problems in the past twenty years; however, most of this research has been confined to studies of food habits and habitat improvement.

Only in recent years has the need for investigation in the field of nutrition of bob-white quail been recognized. Up to 1948 the research (7, 11) has involved primarily the requirements of quail for protein; four minerals, namely, calcium, phosphorous, sodium, and chlorine; and three vitamins, namely, vitamin A, riboflavin (formerly called Vitamin B_2 and Vitamin G), and pantothenic acid (formerly called filtrate factor). Research of this kind is timely and practical. Clarence Cottam, Assistant Director, Fish and Wildlife Service (4) says: "Research on vitamin requirements of bob-white quail suggests a major cause of winter die-off in northern states and has pointed the way to much saner and more effective management at tremendously reduced costs. The same study showed the futility of continued introductions of pen-reared birds into areas north of the birds' normal range."

The present study was undertaken in the summer of 1949 at the request of the Cleveland County Sportsmen's Club in an attempt to discover some of the factors responsible for chick mortality during the rearing period and also during the period from time of release into the wild up to the hunting season. On the basis of previous research by Nestler, Derby, DeWitt and others, on the role of vitamin A in the diet of pen-reared bob-white quail, it was decided to attack the problem from this angle.

PROCEDURE. An experiment involving a total of 207 hatchery reared bob-white quail was set up. The birds were divided into five groups of approximately forty birds each and placed in standard rearing coops. The duration of the experiment was four weeks. The birds were seven weeks old at the beginning of the experiment. The procedure was similiar to that used by Nestler, Derby and DeWitt (11).

The first group was placed on a diet of weed seeds for the duration of the experiment. This diet was not supplemented with vitamin A. The results are complicated by the fact that the amount of the precursor of vitamin A, carotene, in the weed seeds is not known. The carotene content of some weed seeds has been determined but this factor is quite variable according to the season of the year, time in storage, etc., (9). The other four groups were placed on a diet of a commercial game feed mixture which was supplemented with vitamin A in the form of fortified cod liver oil. The levels of vitamin A supplement were as follows: Group 2 — 2,000 I. U. per pound of feed, Group 3 — 4,000 I. U./lb., Group 4 — 8,000 I. U./lb., and Group 5 — 24,000 I. U./lb. To reduce the incidence of picking all five groups of birds were fed fresh lettuce leaves each day for the duration of the experiment (8).

At the end of the experiment approximately one-fourth of the birds in each group were sacrificed. The livers were assayed spectrophotometrically for vitamin A using the Carr-Price antimony trichloride reaction method (1, 2). The results are summarized in Table I.

TABLE I

Storage of Vitamin A in Livers of Growing Quail at End of 11 Weeks.
(I.U. per gram of liver)

Group	Vit. A Supplement per lb. of feed	No. Birds Sacrificed	Vitamin A Storage Average	Range
1	No supplement	9	36.18	12.87- 63.29
2	2,000 I.U.	4	27.35	8.87- 48.81
3	4,000	8	58.35	10.36- 88.97
4	8,000	8	171.37	94-25- 255.29
5	24,000	8	518.75	239.02-1143.81

Utilizing Fisher's "t" test (6) it was found that the difference between the means of the "no supplement" group and the 2,000 I.U. group was not statistically significant. This bears out the findings of earlier research (7) in which it was demonstrated that there is no significant storage of this vitamin in the liver until the level of the vitamin in the diet reaches 2,500 I.U. per pound of feed. Fisher's "t" test applied to all other pairs of data indicated a statistical difference between the means of the pairs.

At this point, it might be well to point out some of the sources of error in a study such as this. In a spectrophotometric assay the I. U. of vitamin A cannot be obtained directly but must be calculated from a standard curve (2, 3). The I.U. of vitamin A is a straight line function of the optical density. In this study, six standard solutions of purified crystalline vitamin A alcohol containing 0, 6, 12, 18, 24, and 30 I.U. per gram of solution were assayed by use of the spectrophotometer. Per cent transmission units taken from the spectrophotometer were transformed to optical density units and the resulting optical density units were plotted against I.U. per gm. of solution. The optical density of each liver extraction solution was then applied to the resulting curve to obtain the results shown in Table I.

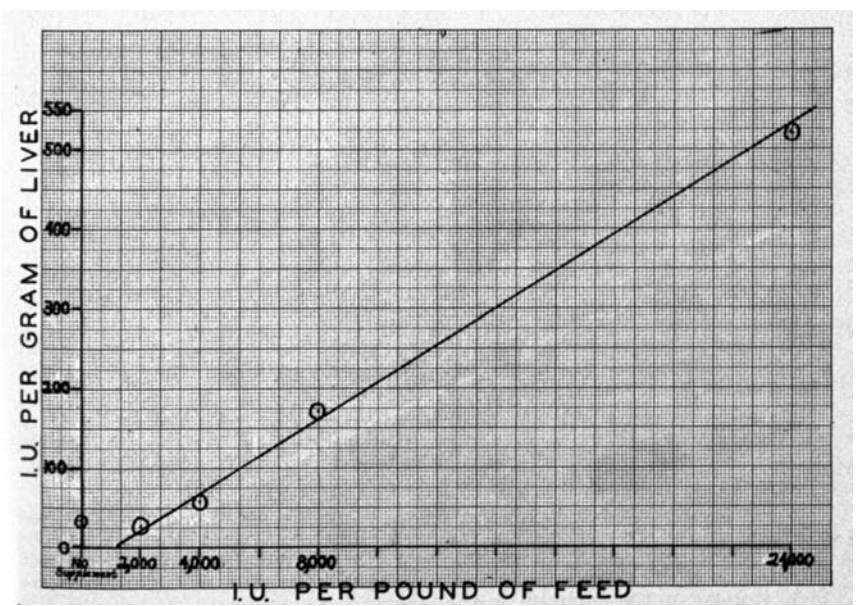

FIGURE 1. Relationship of Concentration of Vitamin A Supplement in the Feed to Average Amount of Vitamin A Stored in the Liver.

The data of Table I are graphically represented in Fig. 1. The points indicating the relationship between the concentration of vitamin supplement in the feed and the amount of vitamin stored per gram of liver lie approximately on a straight line. In other words, vitamin A storage was in direct proportion to the amount of vitamin A added to the diet.

The "notched beak" lesion which is a characteristic symptom of a riboflavin deficiency was observed during the course of this experiment. Ewing in his Handbook of Poultry Nutrition (5) cites cases of this "notched beak" lesion occurring in baby chicks fed on a riboflavin deficient diet. He goes on

FIGURE 2. Photograph of a Pen-reared Bob-White Exhibiting a Characteristic Riboflavin Deficiency Symptom.

to state that crystalline riboflavin and yeast rich in riboflavin tend to cure the condition. The quail exhibiting the "notched beak" lesion was taken from the group which had been fed the highest level of vitamin A (24,000 I.U. per pound of feed). However, this is not of particular significance because of the fact that vitamin A is fat-soluble whereas riboflavin is water soluble (12). Therefore, a plentiful supply of one vitamin does not mean that sufficient quantities of any other vitamin will be present.

Discussion. The author believes that this investigation further emphasizes the value of fundamental research in uncovering basic principles of a sound conservation program.

The State of Oklahoma has been carrying on a program of restocking of hatchery-reared bob-white quail for a number of years. Nestler (7) pointed out that vitamin A deficiency can be reflected in quail for two generations. This fact should be given careful consideration by game managers.

It has been suggested by earlier research by Nestler and others (8) that the feeding of vitamin A supplement to hatchery-reared quail is a good management practice. Not only will this offset a deficiency of this vitamin in commercial feeds but a high enough level will result in a corresponding high storage of the vitamin in the livers of the birds. It is believed this high storage of vitamin A will help to absorb the shock when these pen-reared birds are released into the wild.

Both vitamin A and its precursor, carotene, are easily destroyed in storage by oxidation or rancidity (7). Sportsmen's clubs which care for and raise hatchery-reared quail each year could alleviate this condition in a practical and inexpensive manner. They could incorporate enough vitamin A in the quail's diet to offset the many variables which tend to destroy this vitamin in stored feed. This could be done by using fortified cod-liver oil which contains both vitamins A and D. Approximately one-fourth to one-half pint of this oil will satisfy the needs of 200 birds for four weeks. At the present price the total cost will be between fifteen and twenty cents. As a second practical measure available to sportsmen's clubs planning quail-rearing projects, fresh lettuce leaves should not be forgotten as a means of supplementing the vitamin A content of the diet during the rearing period.

SUMMARY. During the summer of 1949 an experiment involving 207 hatchery-reared bob-white quail was conducted. The objective of the experiment was to determine the amount of vitamin A storage in the liver of quail fed on different levels of this vitamin. The quail were divided into five groups as follows:

Group One — fed on weed seed, no vitamin A supplement.
Group Two — fed on commercial feed, 2,000 I.U. vitamin A supplement added.
Group Three—4,000 I.U. vitamin A supplement added to the commercial feed.
Group Four — 8,000 I.U. vitamin A supplement added to the feed.
Group Five — 24,000 I.U. vitamin A added.

The experiment lasted four weeks. At the close of the experiment approximately one-fourth of the birds in each group were sacrificed and the livers assayed spectrophotometrically for vitamin A storage. The results are presented in Table I. The data of Table I presented graphically (Fig. 1) indicate a direct proportion between the amount of vitamin A storage and the amount of vitamin supplement added to the feed.

A case indicating riboflavin deficiency was observed during the experiment and is discussed briefly.

The source of vitamin A supplement used in this experiment was fortified cod liver oil. Because of its low cost and relative effectiveness in preventing vitamin A deficiency in hatchery-reared quail it is suggested as a practical measure that can be used by Sportsmen's Clubs in this state in their pen-reared quail projects. The value of feeding a high level of vitamin A to the quail to insure a high storage in the liver is emphasized. This high storage helps to absorb the shock of release of the birds into the wild. The value of fresh lettuce leaves as a source of vitamin A is pointed out as another practical measure which can be used in connection with pen-rearing bob-white quail.

It is realized that vitamin A is only one of the many factors which play a major role in bob-white quail nutrition. Its role in quail nutrition is little known as compared to the part played by the minerals. The need for more research on this phase of bob-white quail nutrition is emphasized.

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