VITAMIN A IN POULTRY FLESH AND FAT

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INTRODUCTION

In a previous investigation the writers studied the vitamin B content of poultry flesh and eggs. In this paper they report the results of experiments conducted with rats for the purpose of determining the vitamin A value of the body flesh and fat of several species of domestic fowl. These tests were made on fowls reared under ordinary conditions and fed rations which were in general use. The vitamin A content of eggs has already been reported by several investigators, but there appears to be no information in the literature concerning the amount of vitamin A in the products tested by the writers.

EXPERIMENTAL WORK

FEEDING HISTORY OF FOWLS TESTED

Since it is probable that the vitamin A content of the flesh and fat of poultry is directly related to the amount of that vitamin in the diet of the birds, it seems desirable to record briefly the feeding history of each lot of fowls tested.

Barred Plymouth Rock hens.—This lot of birds consisted of four hens which had been raised on the experiment farm of the United States Department of Agriculture at Beltsville, Md. These chickens, which were hatched in the spring of 1923, had free grass range during the growing period, and were fed a ration previously described by the writers until 6 months old. The pullets were then put in laying pens with moderate-sized yards which contained a fair amount of grass during the growing season. The ration fed to the hens from the time they were 6 months old until October, 1924, consisted of scratch feed made up of equal parts of corn, wheat, and oats, and a mash containing 4 parts rolled oats, 2.5 parts meat scrap, 2 parts bran, 2 parts corn meal, and 1 part middlings, to which was added 5 per cent ground bone and 1 per cent salt. In addition, during the fall and winter months the hens were given a light feed of sprouted oats or cabbage two or three times a week. From October 1 to December 15, 1924, the hens received only scratch feed, after which they were fed mash also, until killed January 13, 1925, when the average live weight of the hens was 5.5 pounds.

Rhode Island Red hens.—This lot of birds consisted of five hens, 22 months old, which had also been raised on the experiment farm at Beltsville. These hens were raised and kept under practically the same conditions as those described for the Barred Plymouth Rock hens. The average live weight of the hens when killed, January 31, 1925, was 5.5 pounds.

Muscovy ducks.—These ducks—three small females and one large male—were purchased from a farm in Beltsville. The male bird was hatched in 1923 and the females in 1924. They were fed lightly on a commercial laying mash supplemented with corn meal and whole corn, and they had free range on which there was an abundance of green feed. No additional green feed was provided during the winter months, but the ducks were able to get considerable green stuff from the range during the early part of that season. The ducks were killed February 25, 1925, the average live weight at the time being 6.3 pounds.

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Pekin ducks.—These birds—3 females and 1 male—were obtained from a dealer who had purchased them from a farmer in Virginia. The ducks were hatched in the spring of 1924, but no information is available concerning their feeding on the farm. The dealer held these ducks for about a month before slaughter, during which time they received only a limited amount of green feed. The ducks were slaughtered March 7, 1925, the average live weight at the time being 4.75 pounds.

Toulouse geese.—Two female geese, approximately 2 years old, were purchased from a farmer near Beltsville. They were raised on free range, and received corn as grain. During the winter previous to slaughter they had a rye pasture and were fed a commercial dairy mash mixed with skim milk. The geese were in good flesh when slaughtered, January 15, 1925, the average live weight being 12.2 pounds.

Embden geese.—Three ganders were purchased alive on the Washington, D. C., wholesale market February 28, 1925. They had probably been raised on near-by Virginia or Maryland farms, but no information concerning their feeding history was available. The geese were killed March 2, 1925, the average live weight at the time being 9.6 pounds.

White Holland turkeys.—One male bird, approximately 21 months old, was purchased February 2, 1925, from a farm near Beltsville. The turkey had been fed a commercial scratch grain, but no mash, and had been allowed free range on which there was a fairly good amount of green feed. The live weight of the bird at the time of slaughter was 23.4 pounds.

Mammoth bronze turkeys.—Two male birds, approximately 10 months old, were purchased from a dealer in poultry who conducts a small farm near Washington, D. C. He purchased the turkeys from farmers in Virginia about November 15, 1924, and held them on his farm for about three months until they were purchased for this experiment. During this period they were allowed a very moderate range, but the amount of green feed was limited at that season of the year. The turkeys were fed only corn during this time. No information is available concerning the conditions under which the turkeys were raised on the farm. The average live weight of the turkeys when killed February 11, 1925, was 15.5 pounds.

Pearl gray guinea fowls, lot 1.—Eight young female guinea fowls, hatched in the spring of 1924, were purchased from a farmer near Hyatts ville, Md. The young guinea chickens were started on a commercial chick feed and were continued on it for a few weeks, and then they were allowed free range. After that they were fed a small amount of corn and wheat, but received no other feed except what they picked up. The amount of green feed on the range during the winter months was undoubtedly very limited, but it was probably greater than that available for the Plymouth Rock and Rhode Island Reds hens from the experiment farm at Beltsville. The average live weight of the guinea hens at the time of slaughter, January 23, 1925, was 2.7 pounds.

Pearl gray guinea fowls, lot 2.—Seven male and two female guinea fowls were purchased from a dealer who had bought them from a farmer in Virginia. The dealer kept the birds on his farm for about a month after purchase, feeding them corn and allowing them free range, but the amount of green feed was limited at that time. No information was available concerning the feeding of the guinea fowls. The average weight of the birds at the time of slaughter, March 9, 1925, was 3.1 pounds.

Promptly after slaughter the muscle and fatty tissues were trimmed from the carcasses of each lot of fowls. The muscle tissue was ground, mixed with water and toluol, and dried to air dryness in a current of air at a temperature not higher than 60° C., the operation requiring less than 24 hours. The dried material was ground, transferred to glass bottles, and stored at a temperature approximating 4° C. until tested for vitamin A. The fatty tissues were rendered on a steam bath at a temperature not higher than 75° C., the operation requiring less than one hour. The rendered fat was filtered into glass jars, which were placed in cold storage at the temperature noted above. The samples of dried poultry flesh were analyzed for protein and fat and each sample of flesh and fat was tested promptly for vitamin A.
METHODS EMPLOYED IN TESTING FOR VITAMIN A

The relative amounts of vitamin A in the samples of poultry flesh and fat were determined by feeding tests with young albino rats, the sample under examination constituting the only known source of this vitamin in an otherwise adequate ration. The rats were raised in the animal laboratory of the Bureau of Animal Industry. Litters containing more than 8 rats were reduced to that number on the day of birth, and those consisting of fewer than 6 were discarded. Only young rats which reached a weight of 40 grams within 30 days from birth were used for test purposes. The breeding rats were fed a ration relatively low in vitamin A.

Each sample of flesh, or fat, was mixed in one or more proportions in rations made up according to the following standard:

<table>
<thead>
<tr>
<th>Basal ration</th>
<th>Parts</th>
</tr>
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<tbody>
<tr>
<td>Protein ((N \times 6.25))</td>
<td>20</td>
</tr>
<tr>
<td>Ash</td>
<td>4</td>
</tr>
<tr>
<td>Yeast</td>
<td>10</td>
</tr>
<tr>
<td>Fat</td>
<td>20</td>
</tr>
<tr>
<td>Starch to make</td>
<td>100</td>
</tr>
</tbody>
</table>

The protein consisted of finely ground commercial casein which had been heated 72 hours in a current of air at an average temperature of \(110^\circ \text{C} \) to \(115^\circ \text{C}\). to destroy vitamin A. The ash mixture was made up according to a formula by Drummond and Watson. Dried bakers' yeast, hardened cottonseed oil, and cassava starch comprised the remainder of the ration. Casein was the only constituent of the basal ration found to require purification from vitamin A.

Each ration was fed to a group of 4 rats. Each rat was kept in an individual cage with a raised-screen bottom. The ration was supplied in a self-feeder, and a record was kept of the feed consumed. The rats were weighed biweekly and they were observed frequently for signs of ophthalmia.

FEEDING TESTS WITH BASAL RATIONS

Each ration containing poultry flesh or fat was fed to a group of rats from the start, without a preliminary test on a vitamin-A-free basal ration, as is the practice followed by many investigators. The procedure which the writers have followed in this work requires that proper allowance be made for the growth made by rats fed the basal rations alone under the same conditions as those existing in the other experiments.

In Figure 1 are shown the results obtained by feeding the basal ration to two groups of rats during this investigation. The rats made but limited growth, and all but two developed ophthalmia. The growth made by these rats probably is due largely, if not entirely, to the reserve store of vitamin A in their tissues, rather than to the presence of this vitamin in the basal ration.

1 The feeding experiments with rats were carried on by George G. Snider and Warren L. Briggs, of the Biochemic Division, Bureau of Animal Industry.

FIG. 1.—Growth of the rats which were fed the basal ration alone. Sex of rats in this and the other figures is indicated by the letters m and f; arrows indicate ophthalmia.

FIG. 2.—Growth of the rats fed the dried flesh of Barred Plymouth Rock hens as the source of vitamin A. The rats represented by the upper graphs were fed a ration containing 10 per cent of the flesh; and those by the lower graphs 20 per cent. Arrows indicate ophthalmia; x indicated severe rhinitis.
VITAMIN A IN POULTRY FLESH

VITAMIN A IN CHICKEN FLESH

In Figure 2 are shown the growth curves of two groups of rats which were fed rations containing 10 and 20 per cent, respectively, dried Barred Plymouth Rock hen flesh. Rather irregular results were obtained, but by calculating the average gain in weight made by each group of rats it will be found that considerably better growth was made by those getting 20 per cent of the dried flesh. However, this proportion of the Plymouth Rock flesh did not furnish sufficient vitamin A for optimal growth.

In Figure 3 are shown the growth curves of two groups of rats which were fed rations containing 10 and 20 per cent, respectively, of dried Rhode Island Red hen flesh. The first group of rats (numbered 640) made very poor growth, and all developed ophthalmia. Although the second group of rats made somewhat better growth, it is apparent that 20 per cent of this lot of chicken flesh did not furnish nearly sufficient vitamin A for optimal growth.

On comparing Figures 2 and 3 it appears that the Barred Plymouth Rock hen flesh was appreciably richer in vitamin A than the Rhode Island Red hen flesh. Since both lots of birds were fed the same ration and handled in the same manner, it appears that the one lot of hens simply stored more vitamin A than did the other.

VITAMIN A IN DUCK FLESH

In Figure 4 are shown the results of feeding tests with the dried flesh from Muscovy and Pekin ducks, respectively. The first group of rats (numbered 657) was fed a ration containing 25 per cent of...
Muscovy duck flesh, and the other group (numbered 660) received a ration containing 30 per cent of Pekin duck flesh. There is a remarkable difference in the amounts of vitamin A in these samples. All the rats getting the Muscovy duck flesh made excellent growth; in fact, rat No. 657A made extraordinary growth. On the other hand, the rats getting the Pekin duck flesh made very poor growth; three of them developed ophthalmia, and one died. It is to be noted, also, that there was 30 per cent of Pekin duck flesh in this ration as compared with 25 per cent of Muscovy duck flesh in the other ration.

The Muscovy ducks had received an abundance of green feed in addition to mash and grain, but the Pekin ducks had only a limited amount of green feed for a month before slaughter, and information on the history of their feeding is lacking.

VITAMIN A IN GOOSE FLESH

In Figure 5 are shown the results of feeding tests with the dried flesh from Toulouse and Embden geese, respectively. Rats numbered
FIG. 5.—Growth of rats fed Toulouse and Embden goose flesh as the source of vitamin A. Rats numbered 634 and 635 were fed rations containing, respectively, 10 and 20 per cent of dried Toulouse flesh. Rats numbered 659 were fed a ration containing 30 per cent of Embden flesh. Arrows indicate ophthalmia

FIG. 6.—Growth of rats fed White Holland and Mammoth Bronze turkey flesh as the source of vitamin A. Rats numbered 648 were fed a ration containing 20 per cent of dried White Holland flesh. Those numbered 653 received a ration containing the same percentage of Mammoth Bronze flesh. Arrows indicate ophthalmia
634 and 635 were fed rations containing 10 and 20 per cent, respectively, of Toulouse goose flesh; and rats numbered 659 received a ration containing 30 per cent of Embden goose flesh. These graphs indicate that both lots of flesh were very poor in vitamin A, although that from the Toulouse geese appeared to contain slightly more than than from the Embden geese. The Toulouse geese had been grown on free range with plenty of green feed, but the Embden geese were purchased from a dealer and no information concerning their feeding history was available.

**VITAMIN A IN TURKEY FLESH**

The results of the feeding tests with two samples of Turkey flesh are shown in Figure 6. Rats numbered 648 were fed a ration con-
taining 20 per cent of flesh from the White Holland turkey, and rats numbered 653 received an equal proportion of flesh from the Mammoth Bronze turkey. Apparently the latter sample of flesh contained slightly more vitamin A, but both samples were very poor in it.

**VITAMIN A IN FLESH FROM GUINEA FOWLS**

In Figure 7 are shown the results of feeding tests with the dried flesh from two lots of guinea fowls. Rats numbered 642 and 643 were fed rations containing 10 and 20 per cent, respectively, of the flesh from the guinea fowls purchased from a farmer near Beltsville, and rats numbered 663 were fed a ration containing 30 per cent of the flesh from the other lot of guinea fowls which were purchased from a dealer. It is apparent from the growth curves of the rats that the first lot of guinea-fowl flesh was very poor in vitamin A. On the other hand all of the rats that were fed the second sample of flesh made remarkably good growth, and it is probable that a considerably smaller percentage of the flesh would have induced optimal growth. Although the greatest percentage that was fed of the first lot of guinea flesh was 20 per cent, whereas the second lot of flesh was fed to the
extent of 30 per cent of the ration, the difference in the growth made by the rats fed the two rations is so pronounced that it seems safe to conclude that the second sample of flesh was considerably richer in vitamin A than the first sample.

The guinea fowls purchased from a farmer near Beltsville had free range and plenty of green feed, but no information was available concerning the feeding of the other lot during the growing period. Apparently, however, the second lot of guinea fowls must have been fed a ration richer in vitamin A or had a much better range than the first lot, as indicated by the wide difference in the amounts of vitamin A in the two samples of flesh.

![Graph](image-url)

**FIG. 9.—Growth of rats which received fat from Rhode Island Red hens as the source of vitamin A.**

Rats numbered 638 and 639 were fed rations containing, respectively, 5 and 10 per cent of the chicken fat.

**VITAMIN A IN POULTRY FAT**

**VITAMIN A IN CHICKEN FAT**

The results of feeding test with rations containing fat from the Barred Plymouth Rock hens are shown in Figure 8. Although rats numbered 625 received only 5 per cent of the chicken fat, and rats numbered 626 received 10 per cent, yet the two groups made practically the same average gain in weight. Growth was considerably below normal.

In Figure 9 are shown the growth curves of two groups of rats fed rations containing 5 and 10 per cent, respectively, of fat from Rhode Island Red hens. Strangely, the rats receiving the larger proportion of chicken fat made the poorer growth. Comparing Figures 8 and 9, it seems that the fat from the Plymouth Rock hens was appreciably richer in vitamin A than that from the Rhode Island Red hens. A similar relation was previously noted concerning the amounts of
FIG. 10.—Growth of rats which received fat from Toulouse greese as the source of vitamin A. Rats numbered 632 and 633 were fed rations containing, respectively, 5 and 10 per cent of this fat.

FIG. 11.—Growth of rats which received fat from White Holland turkeys. These rats were fed a ration containing 10 per cent of this fat.
vitamin A in the flesh from the same two lots of hens. It is interesting to note that each lot of chicken fat was considerably richer in vitamin A than the corresponding lot of flesh (see figs. 2 and 3).

**VITAMIN A IN GOOSE FAT**

In Figure 10 are shown the results of feeding tests with rations containing 5 and 10 per cent, respectively, of fat from the Toulouse geese. Both groups of rats made fairly good, though not quite normal, growth, the rats getting 10 per cent of goose fat making a slightly greater average gain in weight. It appears that this sample of goose fat contained approximately the same amount of vitamin A as the fat from the Plymouth Rock hens (fig. 8). It seems, also, that the fat from the Toulouse geese was much richer in vitamin A than the flesh from the same birds (compare figs. 5 and 10).

**VITAMIN A IN TURKEY FAT**

In Figure 11 are shown the growth curves of rats fed a ration containing 10 per cent of fat from the White Holland turkey. Growth was considerably below normal. Comparing figures 11 and 6, it will be noted that the flesh from this turkey apparently contained much less vitamin A than did the fat from the same bird. This sample of turkey fat appeared to contain appreciably less vitamin A than the sample of goose fat (fig. 10).

**SUMMARY OF RESULTS**

In this paper are reported the results of a study of the concentration of vitamin A in the dried flesh from two lots each of chickens, ducks, geese, turkeys, and guinea fowls, and in the fat from two lots of chickens and one lot each of turkeys and geese.

The flesh from one lot each of ducks and of guinea fowls was found to be relatively rich in vitamin A; one sample of chicken flesh contained a fair amount of this vitamin; but the other samples of guinea fowl, duck and chicken flesh, and both samples of goose and turkey flesh, were relatively poor in vitamin A.

One sample of chicken fat and the sample of goose fat each contained a fair amount of vitamin A, but the sample of turkey fat was rather poor in this vitamin.

In each instance it was found that the sample of poultry fat was considerably richer in vitamin A than the corresponding sample of flesh.

On account of the limited number of samples of each kind of poultry flesh and fat which were tested for vitamin A, no general conclusions concerning the value of any one of these products as a source of this vitamin are justified. Additional information concerning the vitamin A content of poultry flesh and fat is to be desired.