MAINTAINING THE CAROTENE IN POULTRY FEEDS

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INTRODUCTION

Carotene, a normal consituent of most plant life and especially abundant in rapidly growing dark-green succulent leaves and in yellow plant tissues, is synthesized during the process of digestion into Vitamin A, a very important food constituent. Carotene, like vitamin A, is unfortunately a labile compound easily subject to destruction by light and heat. A green grass or plant when cut for hay or food often loses more than half of its carotene when left to dry in the sunshine. If the curing process is prolonged by rains or foggy weather, this destruction is increased. Hay which has been dried and placed in the mow continues to deteriorate owing to the action of oxidative enzymes present. If the green plant can be very quickly dried without exposure to sun and wind as is done in the preparation of dehydrated alfalfa, most of the oxidative enzymes are destroyed by heat and the carotene is preserved for a much-longer period of time. If this process can be hastened by sudden steam blanching of green plant material prior to dehydration, most of the destruction of carotene by oxidative enzymes present in the plant, is prevented. Unfortunately, however, other destructive processes that are somewhat active even in dehydrated foods result in a slow deterioration.

Livestock do not need many of the vitamins required by man owing in part to their ability to secure them from bacterial synthesis, but vitamin A derived largely from carotene is needed for poultry and livestock in the Southwest. This is true not only in winter when grain and dry material make up the bulk of the feed, but also during long periods of summer drought. Inadequate supply and high cost of fish liver oil often forbid its use, so that any means of securing other sources of carotene or of preserving present supplies becomes of great economic significance. This is especially true for mixed poultry feeds which are used in brooders where the chickens have no access to green feed, and, to a lesser degree, for flocks confined to dry-lot feeding.

These statements are founded upon publications generally known and too numerous for complete citation. Certain articles referring to carotene (Fraps and Kemmerer 1938, Heywang and Morgan 1939, Taylor and Russell 1944, Wilder and Bethke 1941), those referring to the increased destruction due to the presence of certain constituents (Fraps, Meinke, and Keiser 1943; Mann 1945; Marcus 1945), and others concerning inhibition of oxidation of carotene (Baumann and Steenback 1933; Bethke, Record, and Wilder 1939; Bickoff, Williams, and Sparks 1945; Holmes, Corbet, and Hartzler 1936; Lovern 1944; Silker, Schrenk, and King 1944; Williams 1943) should be mentioned.

Our experimental work was conducted to measure the carotene of Oklahoma-grown feeds under local conditions both with and without inhibitor.

The experiments here reported were designed to determine: (1) The carotene present in feeds; (2) the rate of destruction as influenced by temperature, humidity, and air currents; (3) methods of preventing deterioration by (a) the use of antioxidants of natural oils and chemicals, and (b) by packaging, pelleting, or sealing.

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EXPERIMENTAL

Series I.

The first experiments were conducted during the winter months, alfalfa leaf meal being used as the natural source of carotene. Ten percent of this meal was mixed with 90 percent of a growing-chick ration (basal)[2] and samples were treated with glycerol monosterate, *VioBin*, *Avenex*, nordihydroguaiaretic acid *(NGDA)*, soybean oil, and alpha-tocopherol, as shown in Table I. One series of samples was stored at room temperature, and a second series was stored at 100° F in moving air. The carotene was determined at intervals by the method of Wall and Kelly (1943). The results of the alfalfa-leaf-meal mixtures are illustrated in Chart 1.

Two outstanding facts that verify many previous reports: The destruction of carotene is hastened by higher temperatures; none of the various inhibitors used are of great value. Several of the natural oils undoubtedly have some value. Soybean oil seemed as satisfactory as any in this and later experiments.

Series II.

The second set of experiments was made during summer months and involved samples containing carotene from alfalfa in a concentrate, extracted with alcohol and ether, from green succulent Sudan leaves, and from samples supplemented with a synthetic vitamin-A concentrate. The content of these samples is listed in Table II. Chart 2 shows the results obtained with the carotene and Chart 3 records the vitamin-A determinations.

TABLE I

Dehydrated-alfalfa and feed mixtures used for measuring the deterioration of carotene, October 1945—January 1946

Alfalfa

(1) Commercial dehydrated alfalfa leaf meal
(2) Basic feed containing 10 percent commercial alfalfa leaf meal

Sterol

(3) Alfalfa leaf meal plus 5 percent sterol dissolved in alcohol
(4) Basic feed plus 10 percent of mixture 3

VioBin Wheat-Germ Oil

(5) Alfalfa leaf meal plus 1 percent *VioBin*
(6) Basic feed plus 10 percent of mixture 5

Avenex

(7) Alfalfa leaf meal and *Avenex*
(8) Basic feed plus 10 percent of mixture 7

NGDA

(9) Alfalfa leaf meal plus 0.2 gm *NGDA* plus 9.08 gm purified soybean oil
(10) Basic feed plus 10 percent of mixture 9

Soybean Oil

(11) Alfalfa leaf meal plus 1 percent soybean oil
(12) Basic ration plus 10 percent of (11)

Alpha-Tocopherol

(13) 964 gm alfalfa leaf meal plus 6 gm alpha-tocopherol

In these mixtures of alfalfa leaf meal and basal ration approximately only 18 percent of the original carotene was retained. The use of *VioBin* in sample 2 resulted in retention of the greatest percentage of the original carotene potency. It will be observed that destruction during the summer months was greater than during the winter.

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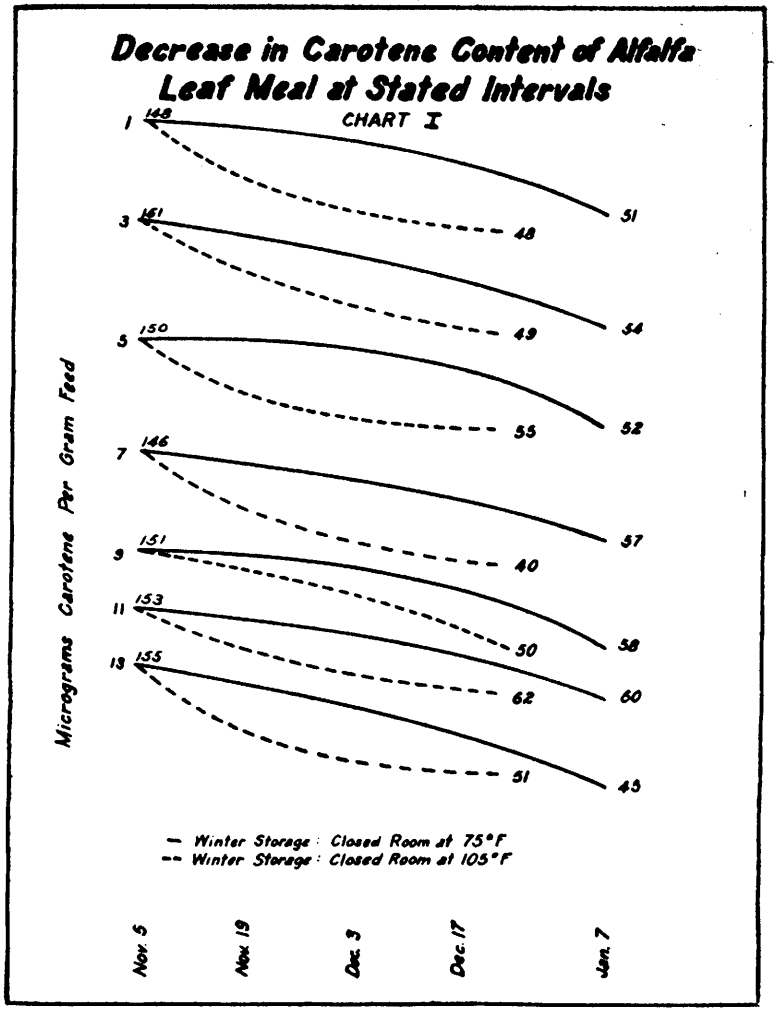
[2]Basal ration (percentages): Ground yellow corn, 22; wheat shorts, 20; wheat bran, 10; pulverized barley, 10; alfalfa leaf meal, 10; cottonseed meal, 5; soybean meal, 5; meat and bone scrap, 10; dried buttermilk, 5; calcium carbonate, 2; and salt, 1.



The vitamin-A samples stored under identical circumstances likewise deteriorated, and the destruction took place in all mixtures. Sample 7, containing soybean oil, retained vitamin A slightly better than the other mixtures. The effect was so small, however, as to be of doubtful significance from an economic standpoint.

Series III.

A third series was carried out in late fall and early winter with dehydrated alfalfa leaf meal as the source of carotene. The completed mixtures in every case were divided into two parts, one being stored under open-laboratory conditions and the other at 105°F in circulating air. In this series five recommended inhibitors were used—a natural soybean oil, lecithin, *Avenex*, *VioBin*, and alpha-tocopherol. The various mixes and the amount of inhibiting supplement in each case are shown in Table III, and the periodic carotene deter-

TABLE II

Mixtures used in testing the stabilizing properties of various antioxidants in the preservation of carotene and vitamin A, June 1946—September 1946

(1) 200 gm alfalfa leaf meal
(2) 200 gm alfalfa leaf meal + 50 gm *VioBin*
(3) 600 gm bran flour + 400 gm vitamin-A mixture[a]
(4) 600 gm bran flour + 400 gm vitamin-A mixture + 100 gm *VioBin*
(5) 600 gm bran flour + 400 gm vitamin-A mixture + 100 gm *VioBin* + 50 gm glycerol monosterate—glycerol monosterate was dissolved in *VioBin* and heated
(6) 500 gm bran flour + 400 gm vitamin-A mixture + 100 gm *Avenex*
(7) 500 gm bran flour + 400 gm vitamin-A mixture + 100 gm soybean oil
(8) 930 gm bran flour + 70 gm carotene concentrate[b]
(9) 930 gm bran flour + 70 gm carotene concentrate + 18 gm *VioBin*
(10) 930 gm bran flour + 70 gm carotent concentrate + 18 gm *Avenex*
(11) 50 gm concentrate mixture 8 + 860 gm basal feed
(12) 50 gm concentrate mixture 10 + 860 gm basal feed

[a]Vitamin-A mixture: 2000 gm bran flour + 1 gm vitamin-A concentrate.
[b]The natural plant carotene concentrate was made by evaporating 400 ml of extract of Sudan upon 200 gm of bran flour.

TABLE III

Mixed feeds containing antioxidants and inhibitors used in carotene determination studies, January 19 to April 12, 1946

Alfalfa

(1) 1000 gm alfalfa untreated
(1m) 910 gm feed mix + 90 gm alfalfa
(2m) Same as 1m but stored in air-proof bag
(3m) Same as 1m but ground finely and stored in bag

Soybean Oil

(4) 980 gm alfalfa + 20 gm soybean oil
(4m) 910 gm feed mix + 90 gm of mixture 4
(5) 955 gm alfalfa + 45 gm soybean oil
(5m) 900 gm feed mix + 100 gm of mixture 5

Lecithin

(6) 910 gm alfalfa + 90 gm lecithin
(6m) 900 gm feed mix + 100 gm of mixture 6

Avenex

(7) 960 gm alfalfa + 40 gm *Avenex*
(7m) 910 gm feed mix + 90 gm of mixture 7

VioBin

(8) 980 gm alfalfa + 20 gm *Viobin*
(8m) 910 gm feed mix + 90 gm of mixture 8

Alpha-Tocopherol

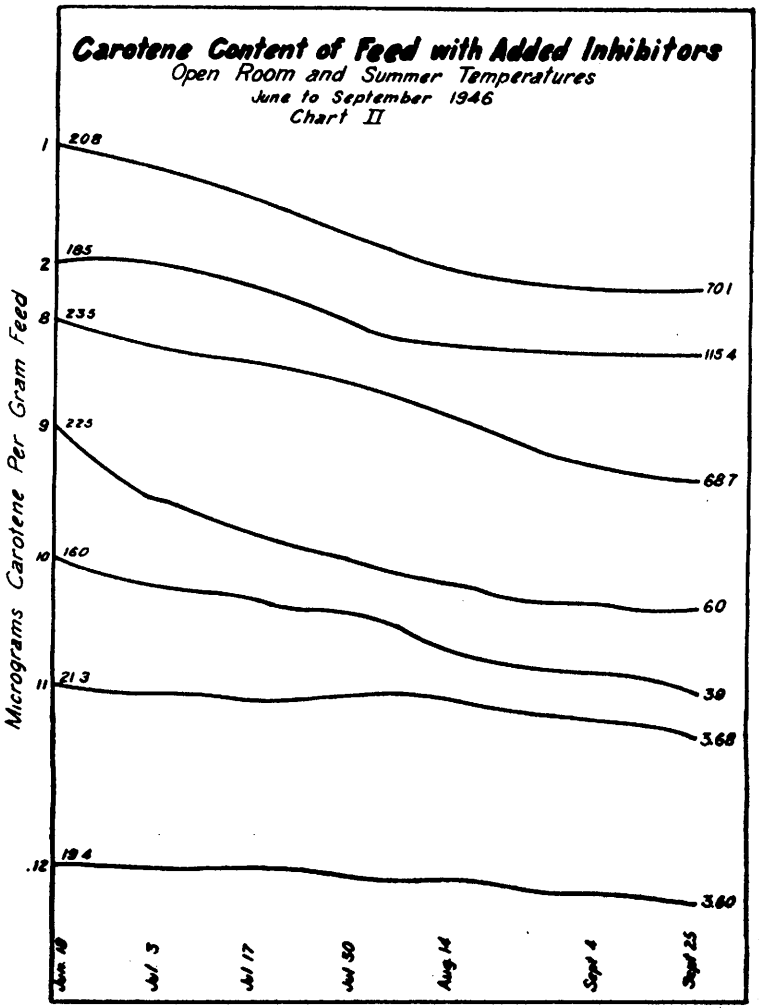
(9) 1000 gm alfalfa + 10 gm alpha-tocopherol

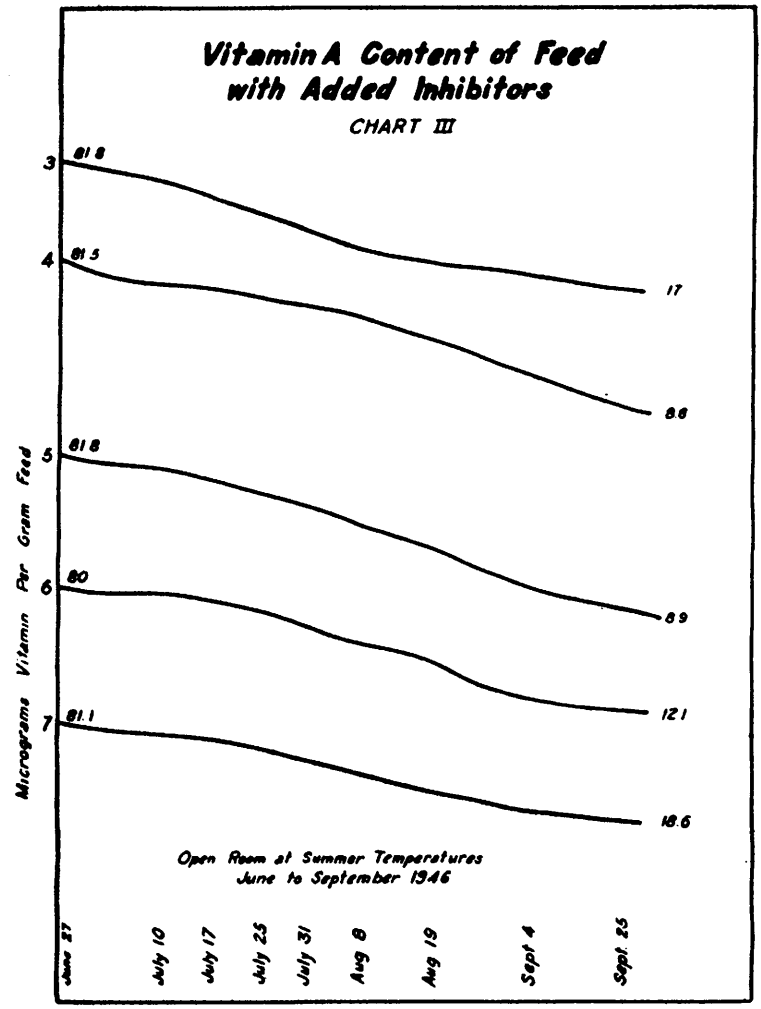
minations are represented in Chart 4. Again there was a marked deterioration at the higher temperature. Also, there was some inhibiting action on the part of antioxidants, notably soybean oil and *VioBin*, but not to an extent of commercial importance in chicken feeds

The most-recent studies have been directed toward finding a method of excluding air from the carotene in the alfalfa, since storing in airproof bags had previously demonstrated better preservation. Some of the methods used were: Pelleting the feed; pelleting and coating with cellulose acetate; coating the meal with an oil; pelleting, and then coating with cellulose acetate; coating the meal with *VioBin* and pelleting; and coating the meal with cellulose acetate and pelleting. The contents of these mixtures are given in Table IV. The decrease in the carotene of these mixtures during June, July, August, and

September under open-room conditions is illustrated in Chart 5. Sample 85 represents the loss in carotene content of the alfalfa leaf meal stored under similar conditions. Apparently the pelleting which should have excluded more air was counteracted by the easy access of air between the pellets, the net result being about equal to that of the finely ground and bagged feed.

These results indicate that carotene deteriorates rapidly in mixed feeds, especially during hot windy weather, and that to date no method is known to inhibit these changes beyond storing the alfalfa in cool dark rooms and mixing small amounts of feed as needed, or relying upon the use of green succulent cereal grasses or leafy feed. A small amount of such natural green feed serves to supply the needed carotene and to maintain the normal carotene content of chicken blood and eggs.




Vitamin A Content of Feed
with Added Inhibitors
CHART III
Micrograms Vitamin Per Gram Feed
3
4
5
6
7
81.8
81.5
81.8
80
81.1
17
8.8
8.9
12.1
18.6
Open Room at Summer Temperatures
June to September 1946
June 27
July 10
July 17
July 25
July 31
Aug 8
Aug 19
Sept 4
Sept 25

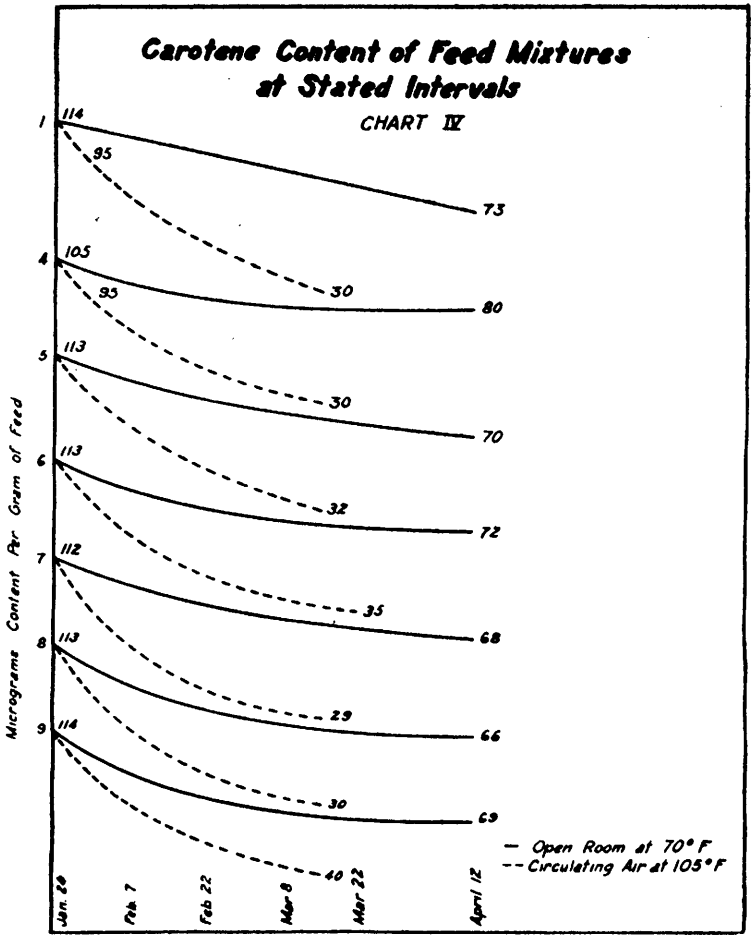
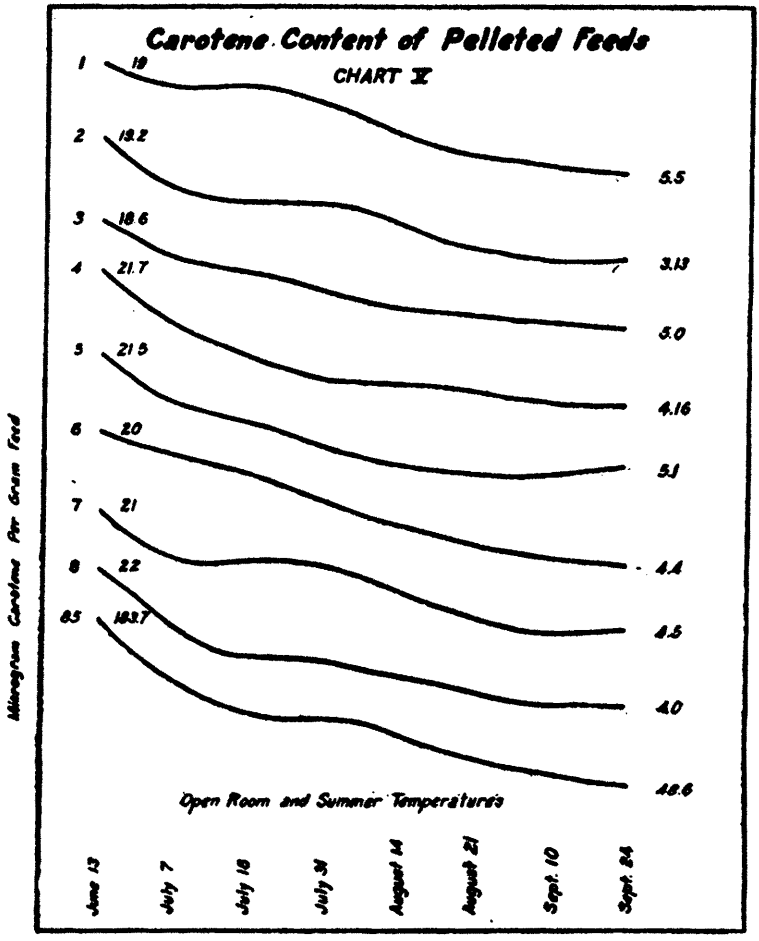


TABLE IV

Method of preparing feed mixtures used in carotene-retention studies, June 13, 1947

Lot 1. 100 lb basal
Lot 2. 100 lb basal pelleted
Lot 3. 100 lb basal pelleted and coated with cellulose acetate
Lot 4. 100 lb basal (minus alfalfa leaf meal) + 10 lb alfalfa leaf meal coated with 2 lb soybean oil—pelleted and coated with cellulose acetate
Lot 5. 100 lb basal (minus alfalfa leaf meal) + 10 lb alfalfa leaf meal coated with 2 lb soybean oil—pelleted
Lot 6. 100 lb basal (minus alfalfa leaf meal) + 10 lb alfalfa leaf meal coated with 4 lb *VioBin*—pelleted
Lot 7. 100 lb basal (minus alfalfa leaf meal) + 10 lb alfalfa leaf meal coated with cellulose acetate—pelleted
Lot 8. 100 lb basal (minus alfalfa leaf meal) + 10 lb alfalfa leaf meal mixed with 2 lb soybean oil and coated with cellulose acetate—pelleted



CONCLUSIONS

Dry ground alfalfa leaf meal is a good source of carotene but aging reduces its potency.

Increased temperature and aeration hasten oxidation.

Various antioxidants, satisfactory in preventing oxidations in oils and fats, have been of some value but not enough to be economically useful.

Storage of feeds in airtight containers is of some value but pelleting and coating the feed has not proved successful.

The use of green succulent cereal grasses as supplements to the feed mix has been the only adequate solution for carotene feeding problems to this time.

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