STABILITY OF CAROTENE IN MIXED FEEDS [1])

J. DAMMERS
State Agricultural Experiment Station, Hoorn

SUMMARY

A study was made of the stability of carotene in dehydrated grassmeal, when the latter was mixed with other feed ingredients. In our experiments 10 % of grassmeal was incorporated in the mixtures. In experiment I the mixture contained cereals, residues from the oil industry and 2 % of minerals. In the mixture of experiment II no byproducts of the oil industry, but 10 % of animal protein feeds were incorporated. The mixed feeds and the original grassmeal were stored under the same normal farm conditions. Carotene determinations were carried out weekly.

The results (in % of the amount of carotene in the first week) are given in table II. Experiment I took place in summer and experiment II in winter ; this may explain the considerable difference in the losses of carotene between the two experiments.

The conclusion is that the destruction of carotene is not increased by the presence of other feeding stuffs.

I INTRODUCTION

From the literature no clear idea can be obtained as to the influence of feed ingredients on the stability of carotene in dried grass or alfalfa, when the latter products are incorporated in feed mixtures. Probably this partly is due to the fact that the feed mixtures examined had a different composition. Hence, a study on the stability of carotene in feed mixtures as used in the Netherlands seemed desirable.

II REVIEW OF LITERATURE

It is a well known fact, that vitamin A and carotene are easily oxidized in the presence of light and air, and that the oxidation velocity is increased by heat. Therefore a considerable part of the carotene is lost by the natural hay making in the sun. During the field curing process the destruction of carotene is influenced by enzymes of the living plant (MITCHEL & HAUGE, 1946).

The losses by artificial drying of grass are considerably smaller than by hay making ; they amount to 15–25 %. When the original product is very rich in carotene, the losses may increase to 40 % (BOSCH and DEYS, 1950).

a *The losses of carotene during storage.* During storage of the dried product the carotene content decreases further. The extent of these losses depends on several factors.

At higher temperatures carotene destruction takes place more quickly. During the summer the average loss of carotene amounts to about 10 % per month and during the winter to 3 to 5 %.

Also a low relative humidity of the air and the presence of light contribute to the oxidation of carotene. According to VON POLHEIM & DIETRICH (1953) especially ultraviolet light is detrimental.

The coarseness of the material is of influence too ; in ground products the losses of carotene are higher.

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Finally it is clear that storage of dried grass, in such a way that the air can easily circulate, causes higher losses. When stored in a room free from oxygen, the destruction of carotene stops at once. Therefore in the United States storage of alfalfa meal in silos with a nitrogen atmosphere is practised sometimes.

b *The stability of vitamin A and carotene when mixed in feeds.* The carotene in dried roughages is more stable than in carotene preparations. Of these last the preparations made from alfalfa are less readily oxidized than solutions of crystalline carotene (FRAPS & KEMMERER, 1937, VON POLHEIM & DIETRICH, 1953). The two last-mentioned authors explain this by assuming that the preparations made of alfalfa still contain natural antioxidants.

Vitamin A is less stable than carotene. The presence of salts of some metals (manganese, copper, iron) may accelerate the destruction of the vitamin. There are some indications that even very small amounts of these salts, as in feed mixtures, still have a harmfull effect (MILLER c.s., 1942). BETHKE c.s. (1939) and SHERWOOD c.s. (1941) found that animal proteins like meatmeal and dried skimmilk stimulate the destruction of the vitamin A in feed mixtures. The same influence is ascribed to rancid fats and glucose (BURNS & QUACKENBUSH, 1951). On the other hand, it is of course also possible that certain parts of the mixture contain anti-oxidants, and in this way could have a stabilizing influence on the vitamin A.

Now the question arises, whether carotene destruction in grassmeal when incorporated in feed mixtures is also influenced by the feed ingredients. It is probable that these influences are not so great as when carotene or vitamin A preparations are used. The covering cell-walls of the dried grass protect to a certain extent the carotene against direct contact with the other feed ingredients. However, the number of investigations carried out on this subject is rather limited and, moreover, the results do not quite agree.

BAUMANN (1950/1951) and HALVERSON & HART (1948) suppose, that such minerals as copper, manganese and iron may contribute to the carotene destruction in mixed feeds. FRAPS & KEMMERER (1937) report that the losses in carotene of dried alfalfa are increased by the presence of cornstarch. BETHKE, RECORD & WILDER (1939) find that meatmeal and dried skimmilk also have an unfavourable influence on carotene stability. They ascribe this effect to the fatty acids of these products. This statement does not fully agree with the observations of MITCHELL & SILKER (1950) who found that the extracted by-products from the oil industry had no stabilizing effect, whereas, on the contrary, the products obtained by the expeller process, which have a higher fat content, still had such an effect. Also rice bran had a favourable influence on the maintenance of carotene, whereas linseed meal stimulated destruction. In a later experiment the same authors (1952) showed, that the carotene of dehydrated alfalfa meal was oxidized less rapidly in mixed feeds than in the undiluted alfalfa meal. The presence of various minerals including copper, cobalt, iron and manganese did not increase carotene destruction. KAMSTRA c.s. (1953) are of the same opinion : they observed that losses of carotene of alfalfa were not materially affected by dietary composition.

Many investigators have proved that in order to stabilize the carotene in natural products, it has no use to apply anti-oxidants as tocopherols, hydroquinone or lecithin (BETHKE c.s., 1939, FRAPS & KEMMERER, 1937, MILLS & HART,

1945). On the other hand, the stability of carotene solutions or vitamin A preparations can be improved considerably by the addition of anti-oxidants.

III EXPERIMENTS ON THE STORAGE OF MIXED FEEDS

The course of the experiments was as follows: Immediately after drying, a certain amount of dried grass was incorporated in a feed mixture. Then this feed mixture and the rest of the grass meal were packed in paper bags containing 50 and 40 kg respectively. Storage took place under normal farm conditions, namely during the summer months in an empty cow-house and during the cold season in the loft.

The experiment was first carried out with a feed mixture for cattle (I), which as usual contained ground cereals, byproducts from the oil industry and 2% of a mineral mixture. In a second experiment a feed mixture with animal protein (fish meal as well as meat meal) was examined. In this mixture (II) no byproducts from the oil industry were included. In order to limit the carotene content of the other components, no corn was used in the feeds. In both experiments 100 kg of the feed mixtures were prepared with 10% grassmeal. The complete compositions of the mixtures were the following:

Mixture I		Mixture II	
20%	ground barley	36%	ground barley
25%	„ millet	12%	„ oats
20%	linseed oil meal	12%	„ rye
8%	coconut oil meal	5%	meat meal
15%	soybean oil meal	5%	fish meal
10%	grass meal	10%	wheat bran
2%	minerals for cattle	8%	tapioca flour
		10%	grass meal
		2%	minerals for swine.

The composition of the mineral mixture was:

for *cattle*		for *swine*	
29.73%	precipitated chalk	50.0%	precipitated chalk
40.0 %	bone meal	32.5%	bone meal
20.0 %	iodinated salt	15.0%	iodinated salt
10.0 %	magnesium sulfate	1.6%	ferrous sulfate
0.15%	copper sulfate	0.3%	copper sulfate
0.10%	manganese sulfate	0.6%	manganese sulfate.
0.02%	cobalt sulfate		

The results of the analysis of the feed mixtures and the grassmeal are given in table 1.

Table 1. Analysis of the feed mixtures and of the dried grass.

		Grass meal dried 23/6	Mixture I	Grass meal dried 30/10	Mixture II
Dry matter	%	85.9	87.1	88.8	86.2
Crude protein	%	17.3	20.6	18.6	15.4
True protein	%	15.3	19.2	15.6	13.1
Crude fibre	%	20.3	7.2	15.2	5.9
Mineral matter	%	9.7	6.0	15.4	6.7
Carotene	mg/kg	332	32.3	332	32.2

Every week a sample was taken from the feed mixtures as well as from the dried grass. In these samples the carotene content was determined according to the method of BOOTH (1945). This was continued during 14 weeks. Also in practice, mixed feeds generally will be consumed three months after the preparation. On Monday and Wednesday samples were taken from the feed mixture and on Tuesday and Thursday from the grassmeal. The determinations on Monday and Wednesday and those on Tuesday and Thursday were considered as duplicates. The average of these duplicate values yielded the result for the week in question.

The examination of mixture I was carried out in the period between June 24 and September 25, 1952. The grassmeal used in this mixture was dried on June 23. The carotene analyses in the mixture with animal protein were made in the period between Nov. 3, 1952 and Febr. 5, 1953. This grassmeal came from the dehydrator on Oct. 30, 1952. As the first experiment was carried out in summer, the losses were much greater than in the second experiment. Therefore the two experiments cannot be compared; only the differences between the losses of carotene in the mixture and those in the undiluted grassmeal can be compared.

RESULTS

Table 2 shows the results of the experiments. In this table the carotene contents are given as percentages of the initial amount. Using the method of least squares, the average weekly decreases in carotene content with their standard deviation, were calculated from all the analytical data. Over the experimental period they amounted to:

experiment I 3.01 % ± 0.19 in the mixture and 4.48 % ± 0.29 in the grassmeal,
experiment II 0.87 % ± 0.14 in the mixture and 0.81 % ± 0.24 in the grassmeal.

In figure I the average decreases are visualized.

Table 2. Stability of carotene in dehydrated grassmeal when mixed in feeds.

Experiment I (from 24/6–25/9)			Experiment II (from 3/11–5/2)		
Week	Carotene preserved %		Week	Carotene preserved %	
	Mixture	Grassmeal		Mixture	Grassmeal
1	100	100	1	100	100
2	104	100	2	95	99
3	105	99	3	97	96
4	99	100	4	96	90
5	90	94	5	99	87
6	89	88	6	94	91
7	87	76	7	97	91
8	83	71	8	–	–
9	79	66	9	92	87
10	78	63	10	92	86
11	77	57	11	93	85
12	70	56	12	88	88
13	70	54	13	89	92
14	67	53	14	86	87

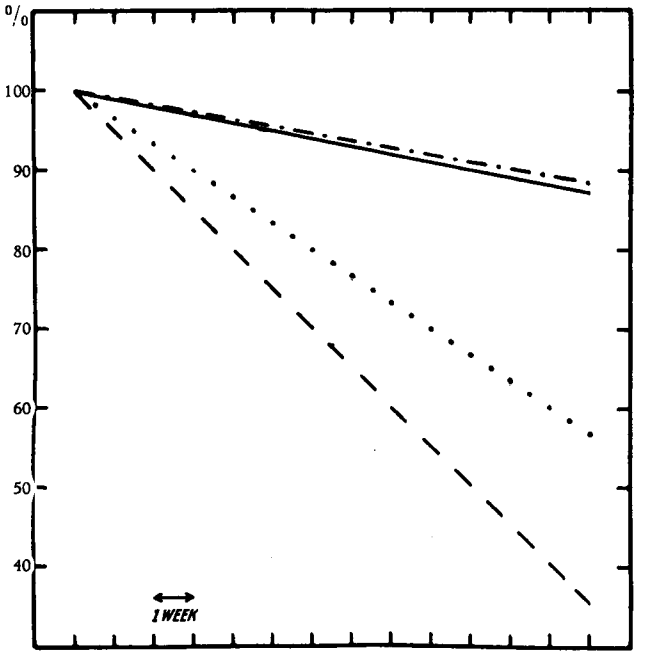

FIG. 1. AVERAGE DECREASE OF THE CAROTENE CONTENT OF DEHYDRATED GRASSMEAL WHEN MIXED IN FEEDS.

..... mixture I } summer 1952
----- grassmeal I }

——— mixture II } winter 1952/53
– · – · – grassmeal II }

In the first trial the carotene content decreased very regularly, in the mixture as well as in the grassmeal. After 14 weeks 67 % of the carotene was preserved in the mixture and still 53 % in the grassmeal. Thus, the presence of the other feeding stuffs rather had a favourable than an unfavourable influence on the stability of the carotene.

In experiment II the losses of carotene in the grassmeal were rather irregular, but the losses in the mixture and in the grassmeal were practically the same, viz. 14 % and 13 %. As already stated, the relative smallness of the losses can be ascribed to the fact that experiment II was taken in the winter.

The second experiment did not show a preserving influence of the other feed ingredients on the carotene content of the grassmeal. Presumably, a possible influence in this direction will be manifested more clearly in the hot season.

The conclusion can be, that the carotene content of grassmeal in feed mixtures does not decrease faster than in the grassmeal as such. Even a mixture with 2 % of minerals and 10 % of animal protein did not affect the carotene destruction.

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