LXIII. VITAMIN K IN THE PLANT

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PREVIOUS investigations have dealt with the occurrence and fate of vitamin K in the plant [Dam, 1934, 1935; Dam & Schønheyder, 1936; Almquist & Stokstad, 1935; Almquist, 1937]; in this paper we have recorded the results of a more detailed study of the problem. We first determined the vitamin in flowers, seeds and roots from green plants and in certain lower plants, and then studied the distribution of the vitamin in relation to the influence of light and darkness on the germinating plant, the withering process occurring in leaves and the well-known degeneration which leads to the formation of chlorophyll-free areas on leaves.

Technique. The plant materials were in most cases dried in vacuum desiccators at room temperature in the laboratory. A few materials were supplied from a manufactory, where they had been rapidly dried by warm air.

The determinations were made by the curative test method used in this laboratory. This method, which was described by Schønheyder [1936], has been steadily developed [Dam & Lewis, 1937] during the work, and is now capable of giving reasonably accurate results. It will be described in a separate paper.

Dam & Schønheyder [1936] showed that direct feeding of dried plant material yielded somewhat lower values than feeding of the light petroleum extract, a fact which was explained by the better absorbability of the extract; the present determinations were, however, all made by direct feeding.

RESULTS.

The following results were obtained. In all cases the figures indicate the number of units of vitamin K per g. dry material.

Green leaves of		Leaves with chlorophyll-free areas	
Alfalfa	200	<i>Codiaeum variegatum</i>	
Alfalfa	300	Green parts	300
Alfalfa	400	Yellow parts	250
Cabbage	400	Withering process	
Spinach	550	Chestnut leaves	
Grass	200	Green	800
Cauliflower	400	Yellow	600
Nettle	400	Brown	800
Chestnut	800	Flowers of	
Pine needles	200	Sunflower	20
Spruce needles	120	Cauliflower	70
Etiolated leaves of		Fruits of	
Peas (+ stem, grown in the dark)	70	Strawberry, ripe	15
Cabbage (inner leaves)	100	Hips, ripe	40
		Tomato, unripe, green	100
		Tomato, ripe, red	50

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Seeds of		Roots and tuber bulbs	
Sunflower	Less than 10	Mangold	Less than 5
Hemp seed	40	Carrots	About 10
Soy bean	25	Potatoes	Less than 10
Pea (ripe for sowing)	14		
Oats	Less than 10	Lower plants	
Wheat	Less than 5	Moss	About 50
Yellow corn	Less than 5	Seaweed:	
Wheat bran	10	<i>Ulva lactuca</i>	130
Wheat germ	Less than 5	<i>Enteromorpha clathrata</i>	140
		<i>Rhododymenia palmata</i>	170
		<i>Ascophyllum nodosum</i>	170
		Lichen	About 30
		Fungus	
		Common mushroom	About 10

Peas germinated in the light and in the dark:

	Wt. g.	Units per g.	Units per plant
Peas before sowing	0.2	14	2.8
Peas grown in the light (275 plants)			
Plant and root, 16 days old	0.0715	300	21.5
Pea, 16 days old	0.0335	35	1.2
		Total	22.7
Peas grown in the dark (204 plants)			
Plant and root, 16 days old	0.0664	70	4.7
Pea, 16 days old	0.0376	25	0.9
		Total	5.6

DISCUSSION

In accordance with previous results green leaves were found to be the most potent source of vitamin K. Among the species examined, chestnut leaves were the most potent. Seeds and roots and some fruits were rather poor sources, while other fruits—tomatoes—occupied a middle position. The outer flowers of sunflowers were rather poor sources while the cauliflower head corresponded in potency to green tomatoes and etiolated leaves (see below). Those lower plants which contained chlorophyll appeared to be somewhat poorer sources than the higher plants. The mushroom, which contains no chlorophyll, was very poor in vitamin K. It was not possible to conclude from the experiment that the fungus had synthesized the small amount of the vitamin which it contained.

Leaves of the chestnut were found to lose only a small portion, if any, of their vitamin K activity when their chlorophyll disappeared during the withering process. Yellow and brown leaves contained about 70–100 % of the vitamin found in green leaves growing on the same tree.

Leaves of the plant *Codiaeum variegatum*, which exhibit large yellow areas alternating with green ones, were found to contain almost as much vitamin K in the yellow parts as in the green, the difference being apparently about 20 % in favour of the green parts, though it may not be significant.

Leaves etiolated in the dark contained much less vitamin K than the corresponding green leaves.

The experiment with peas grown in the light and in the dark for 16 days showed that while a large amount of vitamin was synthesized in the light (about 7 times the amount originally contained in the pea from which the plant germinated) there was only a very limited synthesis in the dark.

The results for soy beans were in conformity with previous results obtained by the preventive method [Dam, 1935] which showed complete protection when 60 % soy bean meal was incorporated in the diet and haemorrhages and clotting times were used as criteria.

SUMMARY

The amount of vitamin K was determined in a series of plant organs by the curative technique.

The richest sources were green leaves of different kinds, chestnut leaves being the most potent among the species examined.

During the withering of green leaves the amount of vitamin K was not much altered.

Leaves which had large yellow areas alternating with green ones contained approximately as much vitamin K in the yellow areas as in the green.

The vitamin K content of flowers, roots and seeds was found to be much less than that of green leaves; mangold root was a particularly poor source.

Certain lower plants appeared to be poorer sources than higher plants.

An experiment with germinating peas showed that whereas there was an abundant synthesis of the vitamin in peas grown in the light, synthesis in peas grown in the dark occurred to a very limited extent.

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