Since vitamin P compounds have been recommended as adjuncts in the clinical use of dicoumarol (*5*), it seemed important to determine any possible interaction between the two. Rats (250–300 gm in weight) were used in accordance with the technique of Overman, *et al.* (*7*). The chemicals under test mixed in cottonseed oil were administered orally on three successive days with the prothrombin time being determined 4 hours after the last dose. Five rats were in each series; dosages were as follows: dicoumarol, 40 mg/kg; vitamin P compound, 80 mg/kg; ascorbic acid, 80 mg/kg; Menadione, 3.2 mg/kg. Results are recorded as average values for each series. Prothrombin times were determined by the method of Campbell, *et al.* (*3*). From these findings, it is apparent that D-catechin and rutin counteract dicoumarol while hesperidin does not. Ascorbic acid counteracts dicoumarol and acts synergistically with D-catechin in this respect.

TABLE 1

PROTHROMBIN TIMES IN RATS UNDER DICOUMAROL TREATMENTS*

	D	D M	D H	D H M	D R	D R M	C D	D C M	D C	D C AA
1.	9'	6'44"	9'33"	12'38"						
2.	15'15"	7'1"	14'51"	10'24"						
3.	10'46"	5'22"	4'35"	13'2"						
4.	11'51"	8'22"			5'38"	8'16"				
5.	14'3"	5'42"			7'33"	3'21"				
6.	12'33"	6'40"			9'21"	7'31"				
7.	11'16"	6'16"					5'21"	4'41"		
8.	5'4"						4'2"		2'26"	47"

* Abbreviations used are: D—dicoumarol; M—menadione; H—hesperidin; R—rutin; C—catechin; AA—ascorbic acid.

Thus, the synergism of ascorbic acid and the vitamin P compounds is found in at least three systems: (1) antihyaluronidase action (*2*); (2) antioxidant action for autoxidation of adrenaline (*9*); (3) counteraction of hypoprothrombenemia produced by dicoumarol.

The significance of the physiological antagonism of dicoumarol and vitamin P compounds is unknown; however, a similar antagonism in bacteriological systems has been reported (*6*). It seems logical that the mechanism controlling hemorrhage in all its phases would be interrelated. One of these mechanisms would be reflected in prothrombin times.

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Effect of *p*-Chlorophenoxyacetic Acid on the Vitamin C Content of Snap Beans Following Harvest

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Attention is being directed toward the effect of plant growth regulating substances on chemical changes that occur in fruits, leaves, and storage organs of plants after they are harvested. Some results of this research have been reported (*2, 4, 6*).

The vitamin C content of snap bean fruits (pods) increases as they develop, reaches a maximum as they attain full size, then decreases, regardless of whether the pods are harvested at this stage of development or left on the plant to mature (*1, 5*).

In extending research in this field, experiments were made to determine the effect of *p*-chlorophenoxyacetic acid on the vitamin C content of bean fruits of marketable size. Bean plants (Black Valentine, Asgrow strain) were grown in a greenhouse. When the largest fruits first attained a size acceptable for commercial use, water mixtures containing various amounts of *p*-chlorophenoxyacetic acid and 1% of Tween 20[1] were sprayed on the attached fruits. Concentrations of the acid used were: 0, 50, 250, 500, and 1,000 ppm.

Samples for vitamin analysis consisted of 6 to 10 replicates of 50 gm each, and values reported are the averages of these replicates. All results are reported on the basis of fresh weight at the time of analysis. The

[1] A sorbitol derivative used as a solubilizer and supplied by the Atlas Powder Company of Wilmington, Delaware.

vitamin C was extracted by the method of Loeffler and Ponting (*3*) and determined in a photoelectric colorimeter. Compensation for turbidity was applied when necessary. Tests with *p*-chlorophenoxyacetic acid and Tween 20 in water showed that the acid and detergent did not influence the vitamin C determinations.

Four days after treatment the fruits were still in a good marketable condition. There was no statistically significant difference between the vitamin C content of untreated fruits and those sprayed with various amounts of the growth regulator.

TABLE 1

EFFECT OF PREHARVEST TREATMENTS WITH *p*-CHLOROPHENOXYACETIC ACID (400 ppm) ON THE VITAMIN C CONTENT OF SNAP BEAN PODS DURING STORAGE PERIODS IMMEDIATELY FOLLOWING HARVEST

Storage period (days)	Av. vitamin C content (mg/100 gm of tissue		Percent decrease in vitamin C content		Percent moisture	
	Untreated	Treated	Untreated	Treated	Untreated	Treated
*Greenhouse—treated July 8, harvested July 12, 1948**						
0	17.6	22.2	...	...	87.8	90.3
1	13.5	21.8	23.3	1.8	88.3	90.5
2	11.7	20.6	33.5	7.2	87.6	89.5
3	11.2	22.0	36.4	0.9	88.1	88.6
4	11.0	19.6	37.5	11.7	87.5	89.9
Greenhouse—treated July 15, harvested July 19†						
0	23.4	24.0	...	...	86.7	90.5
1	17.8	21.8	23.9	9.2	86.9	87.4
2	16.9	21.1	27.8	12.1	84.7	87.9
3	15.4	19.1	34.2	20.4	86.0	86.9
4	13.6	19.7	41.9	17.9	85.8	85.2
Field—treated August 5, harvested August 9‡						
0	26.1	25.2	...	...	91.0	91.7
1	22.6	24.6	13.4	2.4	90.5	90.9
2	19.7	23.7	24.5	6.0	89.2	90.1
3	16.7	22.7	36.0	9.9	88.3	88.1
4	17.8	24.3	31.8	3.6	85.6	89.1
7	15.6	27.2	40.2	+7.4	84.1	82.9
9	12.6	22.2	51.7	11.9	81.9	83.7

* Difference required for significance: 5% level, 1.2 mg; 1% level, 1.6 mg.

† Difference required for significance: 5% level, 1.32 mg; 1% level, 1.75 mg.

‡ Difference required for significance: 5% level, 2.03 mg; 1% level, 2.68 mg.

Additional experiments were made to determine the effect of *p*-chlorophenoxyacetic acid on the vitamin C content of fruits of snap beans during a storage period beginning immediately after they were harvested. When about a third of the fruits on snap bean plants grown in a greenhouse had reached marketable size, they were sprayed with a water mixture containing 400 ppm of *p*-chlorophenoxyacetic acid and 1% of Tween 20. Untreated plants served as controls. After 4 days all those of a marketable size were harvested and spread out separately in a layer (1 to 2 fruits thick) in a room where the temperature varied between 74° and 76° F.

The vitamin C content of the untreated fruits decreased by 37.5% during the 4 days immediately following harvest (Table 1). In contrast, that of treated ones decreased by only 11.7%. At the end of the storage period, treated fruits contained 78% more vitamin C/100 gms of tissue than did the untreated ones, a highly significant difference.

The above greenhouse experiment was repeated. During storage, the vitamin C content of untreated fruits decreased by about 42% during the 4-day period, while that of treated ones decreased only 18% during the same period of time, a highly significant difference (Table 1). At the end of the storage period the treated fruits contained approximately 45% more vitamin C than did the untreated ones.

In another experiment, snap beans were planted under field conditions during the latter part of June 1948. By the first week of August the plants had developed a full crop of fruit, most of which had just reached marketable size. A water mixture containing 400 ppm of *p*-chlorophenoxyactic acid and 1% of Tween 20 was sprayed on the fruits. There were 12 rows of plants in the field. Each row was divided equally, and alternate ends were treated or left untreated.

Four days after treatment all fruits were harvested and handled as previously described. The vitamin C content of untreated ones decreased 31.8% during the first 4 days' storage, that of treated ones only 3.6%, a highly significant difference. After 9 days of storage, the treated fruit contained 76% more vitamin C than did untreated ones.

In both greenhouse and field experiments it was observed that the mixtures of *p*-chlorophenoxyacetic acid checked the growth of fruits that were partially developed at the time of treatment. There was no apparent effect on the size or yield of fruits sprayed when they had attained a size commonly used in the marketing of snap beans.

From this work it is evident that the use of a water mixture of *p*-chlorophenoxyacetic acid and Tween 20 resulted in the maintenance of a relatively high vitamin C content in bean pods following harvest. Further field tests are necessary to determine if this effect is of practical value.

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