COMPARATIVE BIOLOGICAL ACTIVITY OF QUERCETIN AND SOME OF ITS CONVERSION PRODUCTS

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Oral administration of phloroglucin or protocatechoic acid, like that of quercetin, did not affect growth of animals or the ascorbic acid concentration in their organs. Phloroglucin had a tonic action on the capillaries similar to that of quercetin. Protocatechoic acid had a less marked action on the capillaries.

The physiological activity of bioflavonoids has been demonstrated repeatedly. When given to animals, flavonoids undergo profound conversions. Among the metabolic products of bioflavonoids are phloroglucin and protocatechoic acid [4, 5, 7]. These same substances are formed by alkaline hydrolysis of quercetin. However, it has not yet been discovered whether these conversion products themselves possess physiological activity.

The action of flavonols in increasing capillary tone is generally accepted. Information on the effect of flavonols on growth of animals (rats) and the accumulation of ascorbic acid in their tissues is contradictory [2, 3, 6, 8]. The object of the present investigation was to compare the effects of the flavonol quercetin and some conversion products of bioflavonoids (phloroglucin and protocatechoic acid) on the growth of rats, on the skin capillary response, and on the ascorbic acid concentration in the organs of the animals.

EXPERIMENTAL METHOD

Experiments were carried out on albino rats of both sexes weighing about 80 g. The animals were kept on a diet including oats, bread, semolina, meat, vegetables, sunflower oil, and milk. The resistance of their skin capillaries was determined initially by the method described previously [3], using a negative pressure of 200 mm below atmospheric. The animals were then divided into groups in such a way that the time of appearance of petechiae before the beginning of the experiment was as equal as possible, and they were then transferred to an artificial vitamin-P-deficient diet (containing starch, casein, lard, mixed salt), supplemented with vitamins [3]. Altogether there were 4 groups of animals (12-17 rats in each group) in the experiment. The rats of group 1 (control) received only the basic diet, those of group 2 received this diet supplemented by 2.5 mg protocatechoic acid, group 3 the diet supplemented with 2.5 mg phloroglucin, and group 4 the diet with 5 mg quercetin. All the substances were given daily, by mouth, in 0.2 ml water.

Equality of the doses of phloroglucin and protacatechoic acid was established on the basis of the quantity of these substances formed by hydrolysis of quercetin. To determine the effect of the test substances on growth of the rats, the animals were weighed twice a week.

The experiment was carried out in the spring and continued for 1 month. At its end, the capillary response of all the animals was again tested. In 10 rats of each group the ascorbic acid concentration in

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TABLE 1. Mean Weight of Rats at Beginning and End of Experiment

Group of rats	Substance tested	Dose (in mg)	Mean weight (in g)		Mean increase in weight (in percent)
			beginning of expt.	end of expt.	
1	Control	–	84.1	181.5	201.5
2	Protocatechoic acid	2.5	87.1	184.4	211.7
3	Phloroglucin	2.5	84.8	174.1	205.3
4	Quercetin	5.0	83.6	176.3	210.8

TABLE 2. Capillary Response in Rats at Beginning and End of Experiment (M±m)

Group of rats	Substance tested	Dose (in mg)	No. of animals in groups	Mean time of appearance of petechiae (in sec)		P
				beginning of expt.	end of expt.	
1	Control	–	16	37.56±5.36	45.00±9.32	
2	Protocatechoic acid	2.5	15	36.46±6.35	53.27±11.63	>0.2
3	Phloroglucin	2.5	12	28.17±4.79	65.91±13.69	0.02
4	Quercetin	5.0	17	34.00±4.36	67.23±10.61	<0.01

TABLE 3. Mean Concentration (in mg%) of Ascorbic Acid in Organs of Rats

Group of rats	Substance tested	Dose (in mg)	Liver	Kidneys	Spleen	Adrenals
1-	Control	—	30,26	18,75	40,67	443,9
2-	Protocatechoic acid	2,5	27,80	16,20	39,80	481,7
3-	Phloroglucin	2,5	27,35	19,15	36,57	475,2
4-	Quercetin	5,0	29,16	16,98	42,14	461,7

the organs (liver, kidney, adrenals, spleen) was determined by the method normally used in the Institute of Vitaminology [1].

EXPERIMENTAL RESULTS

The rate of growth of the animals in all groups (Table 1) was almost identical, indicating that the tested substances had no effect on this parameter.

The results of measurement of the time for the appearance of petechiae in the rats at the beginning of the experiment and 30 days later are given in Table 2.

As Table 2 shows, the time of appearance of a capillary response in the rats of Groups 3 and 4 by the end of the experiment were almost doubled, indicating that the tonic action of phloroglucin and quercetin on the capillaries is similar. The activity of protocatechoic acid in this respect was low ($P > 0.2$). The very small increase in the time of appearance of the capillary responses at the end of the experiment observed in the control group of animals could be attributed to the change in the animals' age.

The results given in Table 3 show that the substances tested had no effect, under these experimental conditions, on the ascorbic acid concentration in the organs of the albino rats.

This investigation thus showed that phloroglucin and protacatechoic acid, like quercetin, had no effect on growth of the animals or the ascorbic acid concentration in their organs. Phloroglucin had a tonic action on the capillaries similar to that of quercetin, while protocatechoic acid was less active in this respect.

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