37. Vitamin C in Rose Hips

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The very high concentration of vitamin C present in rose hips has been observed by a number of Russian workers [see Iwanoff & Bukin, 1937]. 1380 mg. of ascorbic acid per 100 g. were found in *R. acicularis* and 1540–2580 mg./100 g. in *R. dahurica*. In a more detailed abstract in the same publication, Bukin and Zubkova record the interesting observation that rose hips found in northern latitudes contain more vitamin C than those of species growing further south. The richest samples of *R. cinnamomea* and *R. acicularis*, growing in the northern and middle parts of the U.S.S.R., contained 4750 mg. of vitamin C/100 g. of raw fruit pulp, equivalent to 14.6% of the dried pulp, while *R. canina*, propagated chiefly in the south, contained at best the equivalent of 2.2% vitamin C in the dried pulp. However, not only were the species growing in the north richer in vitamin C than those in the south, but specimens of the same species contained more vitamin C when grown in a more northerly latitude. For example, *R. rubiginosa* from Minsk was found to contain 3880 mg./100 g. compared with samples containing 1400 mg./100 g. from Maikop, further to the south. Another observation seemed to indicate that rose hips growing at high altitudes might be richer in vitamin C than the same species lower down. *R. canina* in the Caucasus mountains was found with 1480 mg./100 g., while hips of the same species taken from the Black Sea shore contained only 470 mg./100 g.

During the past autumn, specimens of a large number of the rose species which grow in this country have been tested for their content of vitamin C. As far as possible only ripe fruit was collected; it was sent to the laboratory by post and there placed in cool storage. In most cases the hips were analysed within a few days of picking. The range of results given below would seem to explain many of the anomalous figures which may arise from individual analyses and also most strikingly confirm the Russian conclusions that species with a more northerly habitat contain higher concentrations than those which grow further south.

EXPERIMENTAL

(1) *Method of analysis*

The 'seeds' or pips—strictly, achenes—of rose hips are hard and difficult to grind and the amount of vitamin C in them is small. The hips were therefore split open, the seeds removed and the proportion of seeds to total fruit determined. Since the number of fully developed seeds fluctuated even in the hips of one species and the hips of some species are drier and less fleshy than others, the proportion of seeds may vary within wide limits. In the present work, the percentage of seeds has been recorded and the analysis of vitamin C carried out on the flesh only. The date of analysis seldom differed by more than a few days from the date of picking; when delay was unavoidable, the hips were kept in cool storage.

To analyse the flesh, a 5 g. sample was ground to an impalpable consistency in a mortar with a small amount of powdered quartz and in the presence of a 5% solution of H_2SO_4 containing 2% freshly dissolved metaphosphoric acid. It is important that the hip flesh be covered with the sulphuric-metaphosphoric acid solution as quickly as possible since enzymes start to destroy the ascorbic acid as soon as the fruit is broken up. The volume of suspension was made up to 500 ml., of which the acid solution comprised about 100 ml.,

the remainder being water. Vitamin C was then determined by titrating 5 ml. of a freshly prepared solution of 2:6-dichlorophenolindophenol with the clear centrifuged solution. The dye was standardized so that 5 ml. were equivalent to about 1 mg. of ascorbic acid.

In most cases the hip solution was only slightly coloured and the end-point was good. Hips from *R. spinosissima* and its allies, however, gave red pigmented solutions which were titrated in chloroform according to the method of McHenry & Graham [1935]. All the figures shown in this paper represent only reduced ascorbic acid. On those occasions when treatment with H₂S was carried out, no increase in vitamin C could be detected. It appears, therefore, as is the case with acid fruits in general, that most of the vitamin occurs in the reduced form.

(2) Vitamin C in British rose species

If rose hips are divided into four groups according to the average ascorbic acid content of the flesh of the ripe fruits, an interesting division of species occurs. In Table 1 below,

Table 1. Range of vitamin C content of the flesh of ripe hips of British roses

Species	No. of samples	Ascorbic acid, mg./100 g. flesh		% pips	
		Range	Average	Range	Average
Group (a), average values more than 1000 mg./100 g.					
<i>Rosa Afzeliana</i>	19	500-1600	1000	21-46	36
<i>R. coriifolia</i>	15	750-1820	1080	24-51	35
<i>R. mollis</i>	11	950-1560	1260	24-58	37
<i>R. Sherardi</i>	19	520-1870	1240	24-55	34
Group (b), average values between 500 and 1000 mg./100 g.					
<i>R. canina</i>	68	200-1010	550	25-52	38
<i>R. dumetorum</i>	38	240-990	590	28-55	38
<i>R. rubiginosa</i>	6	550-1230	810	35-49	41
<i>R. tomentosa</i>	16	340-1180	690	27-55	36
Group (c), average values between 250 and 500 mg./100 g.					
<i>R. agrestis</i>	2	420-500	460	33-37	35
<i>R. micrantha</i>	7	200-650	400	24-49	42
<i>R. obtusifolia</i>	9	150-600	420	33-50	42
<i>R. spinosissima</i>	7	150-760	340	21-29	24
Group (d), average values under 250 mg./100 g.					
<i>R. arvensis</i>	25	10-170	80	26-53	37
<i>R. stylosa</i>	9	70-380	190	33-48	40

an arbitrary division of average values into (a) those over 1000 mg./100 g., (b) those between 500 and 1000, (c) those between 250 and 500, and (d) those under 250 mg. of vitamin C/100 g. was made. After grouping the species in this way, however, it clearly appeared that roses indigenous to Scotland and the north of England fell in the highest group, which included 64 samples. Of these, only 15 were obtained south of the Lake District, 9 being in North Wales and 4 cultivated. The second group contained species with a characteristically English distribution, for the most part extending only to the south of Scotland and there becoming rare. Only 3 of the 128 samples in this group were picked in Scotland. The third group is heterogeneous; *R. agrestis* occurs mainly in southern England, *R. micrantha* grows in England and becomes rare and local in Scotland, *R. obtusifolia* extends as far north as Yorkshire, while *R. spinosissima* has a general distribution but is mainly coastal. Omitting *R. spinosissima*, none of the samples of the other species in group (c) came from further north than mid-Wales. The fourth group comprised roses almost confined to southern England the most northerly samples coming from North Wales.

(3) *Vitamin C in foreign rose species*

In addition to the results for rose species indigenous to this country shown in Table 1 hips of a number of foreign roses have been analysed. These were all from bushes cultivated in Surrey and in few cases was more than a single sample examined.

The foreign rose species also fall into 4 groups which do not correspond exactly with those into which the British roses can be divided. These have average vitamin C contents in mg. per 100 g. of flesh as follows: group (1) over 1500; group (2) 1500–1000; group (3) 1000–500; group (4) below 500. In the following list the figure for the vitamin C content is followed in brackets by the percentage of pips. Group (1), *R. elymaitica* 2080 (20); *R. Fedtschenkoana* 4800 (45), 3050 (35); *R. macrophylla* 1990 (23); *R. Moyesii* 1600 (22), 1250 (26); *R. nutkana* 1660 (33). Group (2), *R. caudata* 1120 (17); *R. cinnamomea* 1180 (23), 1070 (33); *R. manca* 1100 (20); *R. pisocarpa* 1100 (32); *R. pomifera* 1020 (30); *R. rubrifolia* 1030 (37); *R. Sweginzowii* 1430 (24); *R. therebinthinacea* 1370 (28). Group (3), *R. acicularis* var. *Engelmannii* 910 (33); *R. altaica* 520 (20); *R. baicalensis* 590 (30); *R. calocarpa* 930 (29); *R. rugosa* 970 (25), 540 (27); *R. salaeensis* 920 (31); *R. virginiana* 880 (33). Group (4), *R. Helenae* 260 (31).

The first group of foreign roses includes hips very much richer in vitamin C than any of the native species. Of the native material, a specimen of *R. Sherardi* var. *suberecta* contained 1870 mg./100 g., but another sample, possibly of this variety collected late in the year and incapable of exact identification in the absence of leaves, contained 2810 mg./100 g. This was the richest native sample, but it was far surpassed by a Turkestan species, *R. Fedtschenkoana*, grown at Kew, the fresh flesh of which contained 4800 mg. of ascorbic acid per 100 g., i.e. 4.8% of vitamin. *R. Fedtschenkoana* was the only species that gave a figure comparable with that obtained in Russia by Bukin and Zubkova for *R. cinnamomea*. In England the latter species was not outstanding and the reasons for its much lower vitamin content, whether varietal differences or climatic effects, remain obscure. The only foreign rose with a vitamin C content of less than 500 mg. per 100 g. of flesh was *R. Helenae*, the only foreign species tested that belongs to the section *Synstylae*, which includes our native *R. arvensis*. It is notable that many of the foreign rose hips contained a lower percentage of pips than most of the British species. Incomplete fertilization may account for part of the difference, but often it is associated with an elongated shape of the hips as in *R. Moyesii*, *R. Sweginzowii* and *R. caudata* or with thick flesh as in *R. rugosa*.

DISCUSSION

It appears quite clearly from Table 1 that a close correlation exists between the latitudinal range of British rose species and the vitamin C content of their hips. All those with a high vitamin content, group (a), extend throughout Scotland and into north England; group (b) is intermediate and includes species common in England but thinning out in southern Scotland; group (d) is practically confined to southern England. With the exception of *R. spinosissima* which is generally distributed around our coasts, group (c) falls into line in so far as the remaining species have a predominantly southern distribution.

The reasons for this latitudinal variation are not yet clear. Rainfall, sunshine and length of day may play their part, and possibly soil and other environmental factors contribute to the wide range of vitamin content observed in some species. Nevertheless, ascorbic acid content appears to be a constitutional character not readily altered by a change of environment. Thus, transplantation of a bush of *R. mollis* var. *typica* from Westmorland to a garden in Middlesex does not appear to have affected the vitamin content of the hips. It is likely also that much of the variability of certain species is constitutional and not induced by environmental factors as the genetical relationships within this polymorphic genus are known to be complex.

Part of the variation may be attributed to varying degrees of ripeness in the hips. Quiller [1939] reported that the ascorbic acid content of rose hips increases during maturation and decreases when the fruits are over-ripe. In our studies the changes in vitamin C content have not been followed from the green stage to full ripeness, but an increase was found from the orange ripe stage to full ripeness in the hips of a bush of *R. rubiginosa*. The sampling dates and vitamin C contents were as follows: 12. ix. 41, 635; 14. x. 41, 745; 12. xi. 41, 995 mg./100 g. of flesh. A bush of *R. dumetorum*, first sampled when the hips were red ripe, gave the following results: 29. viii. 41, 920; 26. ix. 41, 850; 20. x. 41, 990; 14. xi. 41, 930 mg./100 g. of flesh. No marked decline in the vitamin content of the over-ripe hips of the final sample was evident; had there been much loss of vitamin, it was masked to a large extent by the drying and shrivelling of the fruit. Variation due to the stage of ripeness was kept to the minimum by asking those collecting specimens to supply ripe hips and by a judicious selection of 'ripe' hips from each sample.

Another possible source of variation is the difficulty of distinguishing hybrids from their parent species, especially when only scanty material is available. It is probable that more hybrids exist than have so far been recognized, but this and other taxonomic questions will be discussed elsewhere. The nomenclature adopted is that of Wolley-Dod [1930-31].

SUMMARY

1. A survey has been made of the vitamin C content of the ripe hips of a number of British roses. Some foreign roses grown in this country have also been investigated.
2. A number of common species contain large amounts of vitamin C, often exceeding 1%, in the flesh of the ripe hips.
3. The species indigenous to Scotland and northern England appear to contain higher concentrations of vitamin C than those roses commonly found in the more southern parts of this island.

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