only slight histological changes, have a similar composition to the adjoining necrotic tissue. In neither of these instances does cellular infiltration occur. It seems, therefore, that the chemical changes observed indicate an actual alteration in the composition of the liver protoplasm. It also appears that these changes are qualitatively not characteristic of established necrosis but occur, at least to some extent, at the inception of cellular damage.

A remarkable feature of these alterations is that they appear suddenly. Where hepatic necrosis appears in a few animals of a group, then, if the whole group is killed, it is found that the livers are either necrotic and of abnormal composition, or normal both in appearance and composition. There is no transition between the two, nor any evidence of a gradual alteration in composition leading steadily to necrosis. It thus seems that at a particular time after exposure to appropriate dietetic conditions some sudden derangement of metabolism occurs in the liver; and this leads to necrosis and the observed

alterations in liver chemistry. The question whether these alterations are the result or the cause of cellular damage is of minor importance for in either case they must be secondary to that sudden derangement of metabolism in the liver cells.

SUMMARY

1. Livers affected by acute dietetic necrosis show, as compared with livers from normal rats, increased amounts of water and protein and an absence of glycogen. There is no increase in non-protein nitrogen, and no relationship between the fat content of the liver and the development of necrosis.

2. Livers with healed necrotic lesions do not show these abnormalities.

3. The increased weight of necrotic livers is satisfactorily accounted for by their increased content of water and protein, and some, at least, of the extra protein and water seems to be derived from plasma.

4. The alterations in composition appear suddenly with the onset of cellular damage.

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Observations on the Nature of Vitamin P and the Vitamin P Potency of Certain Foodstuffs

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The material first described by Szent-Györgyi and his co-workers (Armentano, Bentsáth, Beres, Rusznyák & Szent-Györgyi, 1936) as increasing capillary resistance in man was called by them citrin or vitamin P. Subsequent statements (e.g. Szent-Györgyi, 1937) that citrin is a mixture of the flavanone glycosides hesperidin and the more soluble and more active eriodictyol glycoside (called eriodictin) have not, so far as we know, been supported by any published evidence. The chemical nature of many active extracts is unknown, but vitamin P activity has been attributed variously to flavones, flavanones and flavanols.

Mager (1942) attempted a chromatographic analysis of citrin and isolated a faintly yellow crystalline product (m.p. 184–186°) which was identified as eriodictyol rhamnoside. Crystalline eriodictyol was obtained by hydrolysis (m.p. 258–60°). There is no report of any biological test having been carried out on this material, which was readily soluble in water, gave an intense cyanidin reaction and a transient green colour with ethanolic FeCl₃. Previous chromatographic studies by Robeznieks (1938) had indicated the presence in citrin of an unidentified flavonolglycoside similar to quercetin, in addition to hesperidin and eriodictin. According to Bentsáth,

Rusznayák & Szent-Györgyi (1937), quercetin has no vitamin P activity in guinea-pigs, although it is said to lower the blood pressure when administered intravenously to cats (Armentano, 1938).

From citrin prepared from lemon peel Higby (1943) obtained hesperidin (m.p. 261–2°), 'limonin' (m.p. 291–2°) and eriodictyol glycoside from which crystalline eriodictyol was isolated (m.p. 267°). These materials neither reduced arterial blood pressure nor increased capillary resistance. In the course of this work a 'water-soluble yellow pigment' which reduced blood pressure and increased capillary resistance in mice was identified as a glycoside of hesperidin chalcone (2':3':6-trihydroxy-4':methoxy-chalcone-4-glucoside), m.p. 110–112° with decomposition. It was much more soluble in neutral solution than hesperidin, which is virtually insoluble at pH 7. It gave a bright yellow colour in the Wilson boric acid test (Wilson, 1939) but no cyanidin reaction. Higby considers that hesperidin in soluble form can function as vitamin P but pure hesperidin is said to be without effect on capillary fragility, probably as the result of its relative insolubility (Majovski, Lesser, Lawson, Carne & Thienes, 1944). Apart from the chalcone and the natural form in citrus fruits, soluble derivatives of hesperidin are said to include 'the sodium, calcium and other alkali and alkaline earth salts, which exist only at pH values of 11.0 or higher' (Higby, 1943).

Wawra & Webb (1942) described the isolation from citrin, obtained from lemon peel by the method of Szent-Györgyi (1938), of bright yellow microcrystals (m.p. 251–252°) which they considered to be hesperidin chalcone. This material decreased capillary fragility (increased resistance), but was insoluble in water. It reverted to hesperidin (m.p. 261–262°) when suspended in absolute methanol, especially in the presence of traces of anhydrous HCl. These observations differ from those of Wilson (1939) and of Higby (1943), both of whom found hesperidin chalcone to be an orange-yellow powder soluble in water and sintering at 110–112° (Higby, 1943). Wawra & Webb's suggestion that Szent-Györgyi's eriodictin is really hesperidin chalcone is hardly consistent with Mager's work already referred to.

It has been observed by Russell & Clark (1939) that 6-hydroxy-chalcones readily isomerize. The change in the case of hesperidin may be represented thus:

R = sugar residue.

An acid reaction and the application of heat displace the equilibrium to the right. It is to be expected, therefore, that crystalline hesperidin will vary in both colour and melting-point according to the condition of its preparation and more particularly in relation to the method of precipitation. Hesperidin chalcone (Higby, 1943) reverted easily to hesperidin in solution and even when kept in the dry state, but the closure could be prevented by methylating the 6-OH group as suggested by Wilson. It lowered the blood pressure and reduced capillary fragility in animals. A method for the preparation of hesperidin chalcone is given by Higby (1943) which utilizes the fact that the chalcone can be extracted into *n*-butanol.

More recently rutin (a rutoside of the flavonol quercetin) has been reported to increase capillary resistance in man (Griffith, Couch & Lindauer, 1944) and catechin (3:5:7:3':4'-pentahydroxyflavan) has been described as the most active compound known (Lavollay & Parrott, 1942). Confirmation of the activity of these compounds would dispose of Szent-Györgyi's view (Bentsáth *et al.* 1937) that the configurations of the 1 and 2 C-atoms are of special importance.*

In this paper are reported experiments with pure hesperidin and the aglycone hesperetin together with observations on the vitamin P potency of certain foods and fruit extracts. The results have already formed the substance of communications to the Biochemical Society (Scarborough, 1941*a*, 1943).

EXPERIMENTAL

Clinical material

All the subjects had decreased capillary resistance which was elevated by administration of the test material. All were in hospital throughout the investigation, taking diets from which known sources of vitamin P had been eliminated. The capillary resistance was determined by a negative pressure method (Scarborough, 1941*b*).

Test material

For the preparation of the first two substances mentioned below the author is greatly indebted to members of the scientific staff of Glaxo Laboratories Ltd., to whom is partly due the following account of their separation:

(1) *Hesperidin* is the 7-rhamnoglucoside of 5:7:3'-trihydroxy-4'-methoxy-flavanone. A sample of pure hesperi-

* We have now confirmed by clinical assay that rutin is active; its potency is about 5000 provisional units/100 g.

din was obtained from the fraction H (Scarborough, 1939) as prepared from desiccated Californian Valencia oranges (orange meal) by repeated pyridine extraction. Separation was achieved by further extraction with pyridine with the production of a faintly yellow, hygroscopic, crystalline substance which melted at 255–256° with decomposition, the melting-point being, however, lowered if the determination was made very slowly. The melting-point of hesperidin is given by King & Robertson (1931) as 251–252° with decomposition at 254°.

There is apparently considerable variation in the melting-point of specimens of supposedly pure hesperidin (Table 1), which may be due to admixture of the flavanone and chalcone in the specimens examined.

Table 1. *Melting-points of hesperidin preparations*

	°C.
*Tunman (1915)	252
Hall (1925)	245–248.5
*Asahina & Inubuse (1929)	251
King & Robertson (1931)	251–252
*Tseng & Yu (1936)	261–262
Bruckner & Szent-Györgyi (1936)	261
Zilva (1937)	260
Moll (1937)	254
*Morii (1938)	252
Wawra & Webb (1942)	261–262
Higby (1943)	261–262
Scarborough (1944)	255–256

* Quoted from Mar (1939).

The material was almost insoluble in water but was freely soluble in 10% Na_2CO_3 with the formation of a bright yellow solution from which a yellow powder separated as the pH was adjusted to 6.0 with dilute mineral acid. The cyanidin reaction for flavanones performed by adding the solid substance to a reacting mixture of Mg ribbon (or Zn dust) and conc. HCl produced a vivid magenta colour presumably due to reduction of the flavanone to the corresponding anthocyanidin (Armstrong & Armstrong, 1931). The boric acid reaction for flavones described by Wilson (1939) was not obtained. Since, according to Higby (1943), hesperidin chalcone gives a brilliant yellow colour in the Wilson boric acid reaction but a negative cyanidin test, it is concluded that the material as administered consisted almost entirely of the flavanone. The possibility of its containing a trace of the chalcone cannot, however, be excluded. A solution of the material in aqueous methanol gave a bluish violet colour with ethanolic FeCl_3 . Following acetylation with acetic anhydride and sodium acetate at 100° for 4 hr., an acetyl derivative m.p. 175–176° was obtained. King & Robertson (1931) describe the octa- or nona-acetyl derivative of hesperidin (analysis does not permit differentiation) prepared by this method as giving m.p. 175–176°.

The material was finally subjected to hydrolysis but was found to be unaffected by the method described by Blount (1933) for the hydrolysis of rutin, viz. boiling for 2 hr. with 2% (v/v) H_2SO_4 . According to Tiemann & Will (1881) hesperidin is hydrolyzed to the aglycone hesperetin and a sugar moiety (rhamnose + glucose) by 2% (v/v) H_2SO_4 in a 1:1 mixture of ethanol and water in a sealed tube in 3 hr. An attempt was made to carry out the hydrolysis with aqueous ethanolic H_2SO_4 of this concentration by reflux

under atmospheric pressure. Even after 40 hr., however, about 90% of the hesperidin was unchanged. However, isolation of the more soluble material followed by crystallization from aqueous acetone and aqueous methanol finally yielded hesperetin as colourless plates—m.p. 223–234° (225–226°, Heilbron & Bunbury (1936))—readily soluble in acetone and methanol and giving a reddish violet colour reaction with ethanolic FeCl_3 .

(2) *Hesperetin* (5:7:3'-trihydroxy-4'-methoxy-flavanone) was obtained by hydrolysis of a specimen of the hesperidin prepared as described above, by refluxing for 5 hr. with 2% (v/v) H_2SO_4 in a 3.5:2 (by volume) acetic acid-water mixture. Hydrolysis occurred readily and completely. After one crystallization from aqueous acetone the material melted sharply at 223–224°.

Both hesperidin and hesperetin are relatively insoluble in water, hesperetin almost completely, but both are soluble in dilute mineral acid and alkali, especially in the latter. Both substances were administered in aqueous suspension in doses of 0.5–1.0 g. daily to subjects in whom fractional gastric analysis had previously revealed normal gastric secretion of hydrochloric acid.

(3) '*Citrin*'. This is an aqueous solution (50 mg. in 1 ml.) of the solid material obtained from whole lemons by the method of Szent-Györgyi (1938). It was supplied by Roche Products Ltd. and is similar to the material referred to in previous communications as fraction E.G. It contains at least two substances, neither of which has been identified. One is relatively insoluble in water and is light yellow in colour; it can be separated relatively easily from the golden yellow solution which contains at least one other much more highly coloured substance. The latter separates from solution with great difficulty. The solution is still highly active after separation of the light yellow substance but warming the aqueous solution in air destroys its potency. It was administered by mouth or by intramuscular or intravenous injection in amounts of 100–200 mg.

(4) *W.S.P.1*. This was a slightly hygroscopic brownish-yellow powder. Its method of preparation from orange meal, i.e. the peel and pulp of oranges freed from juice and dried in warm air, followed Szent-Györgyi's procedure (Szent-Györgyi, 1938) for the preparation of citrin though with some modifications. The water-soluble material was treated with $\text{Ca}(\text{OH})_2$ and methanol, the precipitated complex which contained about 19% of Ca being designated *W.S.P.1*. It was used in the form of an aqueous solution containing 50 mg. in 1 ml. This solution was darker in colour than the citrin described above, contained none of the relatively insoluble material present in citrin, and became gradually darker in colour on storage in the refrigerator though apparently without loss of activity. *W.S.P.1* was supplied by Glaxo Laboratories Ltd., through the courtesy of Mr A. L. Bacharach, and was administered parenterally, usually in doses of 100 mg. daily.

Biological activity

With the adaptation of the negative pressure method of assessing capillary resistance to the determination of the 'critical petechial pressure' in guinea-pigs (Bacharach, Coates & Middleton, 1942), a biological method for the assay of vitamin P preparations has become available. *W.S.P.1* has been used as a provisional standard in the biological

assay of vitamin P potency, 1 mg. of W.S.P.1 being taken as having 1 unit of vitamin P activity when used in such assays (Bacharach & Coates, 1942). Biological tests on guinea-pigs have shown that the activity of W.S.P.1 is ten times that of hesperidin recrystallized from methanol. The activity of W.S.P.1 cannot be accounted for by the presence of hesperidin itself on the basis of the respective figures for optical rotation and ultra-violet absorption (Bacharach, personal communication).

RESULTS

To save space, description has been limited to typical cases. Fig. 1 shows the effect of pure hesperidin in increasing capillary resistance. This experiment (with chemically pure hesperidin) has been performed on nine occasions in six different subjects. In Fig. 2 is demonstrated the effect of the aglycone hesperetin following an initial period of hesperidin administration. The activity of hesperetin has been

Fig. 1. The effect of the oral administration of pure hesperidin in increasing capillary resistance. Ascorbic acid 100 mg. *per diem* by mouth.

In all figures, each representing one subject, the capillary resistance values have been plotted separately for each of three areas of skin.

In clinical experiments the effect of 100 mg. W.S.P.1 given parenterally has been found to be approximately equivalent to 1 g. hesperidin given by mouth or to 150 mg. citrin by injection (Figs. 1, 3). Disregarding the difference in the methods of administration, therefore, and assuming that all the hesperidin is absorbed, it is found that 100 units of vitamin P activity $\equiv$ 100 mg. W.S.P.1 $\equiv$ 1 g. hesperidin $\equiv$ 150 mg. Szent-Györgyi's citrin. These figures may tentatively be taken to suggest that man and the guinea-pig react towards preparations of vitamin P in a quantitatively similar manner. If this suggestion finds further support, then the very inconvenient and inaccurate assays on human subjects may be replaced by guinea-pig assays.

obtained in three different subjects on six occasions in all. In Fig. 3 is shown the activity of W.S.P.1 and of citrin, both given parenterally.

Assay of vitamin P potency. If the definition of a provisional unit (p.u.) of vitamin P potency given by Bacharach & Coates (1942) be accepted, it becomes possible to assay foodstuffs, fruit extracts and concentrates by comparing the effect of these in increasing capillary resistance in man under carefully controlled conditions with the effect of either W.S.P.1 or hesperidin. The former will be a more acceptable standard on account of the insolubility of hesperidin and the possibility that an unknown proportion of the total dose administered may escape absorption. It should still be possible to carry out such assays, which are, however, very

Fig. 2. The effect of the oral administration of the aglycone hesperetin in increasing capillary resistance. Ascorbic acid 250 mg. *per diem* oral.

Fig. 3. The effect of the parenteral administration of two different water-soluble products in increasing capillary resistance. i.m. = intramuscular.

laborious and cannot at best be more than approximate, even if the response of all subjects to the same dose of standard is not identical, as in fact it is not. It must, however, be established that the response in the 'test subject' to a given dose of the standard remains reasonably constant throughout the period of the assay, which indeed it does. This procedure is based upon the assumption that the level of capillary resistance is not markedly influenced by previous administration of vitamin P. This assumption is justified in practice over periods of 4-6 weeks if the patient be on a standard diet containing few known sources of the vitamin. It can be shown that, after the administration of test material containing vitamin P, the capillary resistance quickly returns to the level obtaining before the experiment began.

The results of clinical assays of certain foodstuffs are given (Table 2) and agree well with values found by Bacharach & Coates (1943) for guinea-pig assays.

Table 2. *Vitamin P potency of foods*

Potency is given in provisional units (P.U.)/100 g. of food.)

Group 1. 'Good' sources. Over 100 P.U./100 g.	
Grape: black, whole fruit	500-1000
white, whole fruit	500-1000
Lemon: whole fruit	500
juice	500-750
Orange: whole fruit	300-500
juice	300-600
peel	200-300
Plum, blue: whole fruit	100-200
Prune: whole fruit	300-400
Blackcurrant: purée	200-300
Group 2. 'Moderate' sources. About 100 P.U./100 g.	
Grape-fruit: whole fruit	100
Apricot: dried whole fruit	75-100
Plum: Victoria, whole fruit	50-100
Cherry: whole fruit	100
Blackberry: whole fruit	80-100
Bilberry: whole fruit	100
Group 3. 'Poor' sources. Under 100 P.U./100 g.	
Tomato	50
Lettuce	Under 50
Cabbage	
Cauliflower	
Turnip	Negligible
Carrot	
Parsnip	
Beetroot	
Potato	

It will be noted that materials usually found to be rich in ascorbic acid are not necessarily those with the highest vitamin P potency and that there is little correlation between the latter and colour. Grapes are the most potent natural source of vitamin P that we have examined (500-1000 P.U./100 g.); the ascorbic acid content of grapes varies between 1.0-7.2 mg./100 g. (Bicknell & Prescott, 1942). The tomato, with ascorbic acid between

12.9-39 mg./100 g. (Bicknell & Prescott, 1942), contains only about 50 P.U. of vitamin P/100 g.

The potency of these natural sources of the vitamin is greatly exceeded by certain extracts and concentrates (Table 3).

Table 3. *Vitamin P potency of concentrates, extracts, etc.*

(Potency is given in P.U./100 g. of concentrate, etc.)

*W.S.P. 4 (from blackcurrant)	300,000
†'Citrin' (from whole lemon)	65,000
‡'Hipexa' (from rose-hips)	20,000-30,000
W.S.P. 1 (from orange meal)	100,000
Hesperidin; recryst. m.p. 265-266°	10,000
Hesperetin; recryst. m.p. 223-224°	2,500- 5,000
§ Rose-hip syrup	500

* Prepared by Dr A. Pollard of Long Ashton Research Station and provided for examination by Mr A. L. Bacharach.

† Prepared by the method of Szent-Györgyi (1938) and supplied by Roche Products Ltd.

‡ Prepared and supplied by Dr F. Wokes, Ovaltine Research Laboratories.

§ Representative value for commercial preparations bought in the open market.

Daily requirement for vitamin P. In two subjects with scurvy, previously discussed (Scarborough, 1944), in whom the capillary resistance was low as the result of their deficient diets, the daily intake of vitamin P required to maintain a high level of capillary resistance was of the order of 300 P.U./day administered by mouth as two different preparations—hesperidin and an extract made from rose-hips. From Table 2 it is clear that this amount of vitamin P should be contained in 50-100 ml. of orange juice, which might therefore be taken to be the minimum daily dose protective against a fall in capillary resistance in man. In this connexion it is of interest to recall the observations of Göthlin (1931), who concluded that 50-70 ml. of fresh orange juice (0.7-1 ml./kg./day) was the minimum daily dose protective against scurvy in man. This conclusion was based upon the results of studies designed to find out what was the minimum daily dose of orange juice which would maintain a normal capillary resistance estimated by a positive pressure method in two physically healthy adults fed by stomach tube a diet containing eggs, sugar, and autoclaved milk. In 1931 it was believed that the factor in orange juice which increased capillary resistance, and the lack of which was reflected in abnormally fragile capillaries, was ascorbic acid, and Göthlin's experiments were the first to be directed towards determining the minimum daily requirement (50-70 ml. of orange juice which should contain 30-40 mg. of ascorbic acid). It seems to us significant that the results of these two sets of experiments carried out for such different reasons should coincide so remarkably.

The stability of vitamin P. The ability of preparations containing vitamin P to increase capillary resistance in man is destroyed by boiling the solution in air. This loss of activity is associated with a darkening in colour of the solution. Shaking an active solution with animal charcoal removes its colour and destroys its potency, which is not restored by the addition of ascorbic acid to the solution. In this connexion it is of interest to note that Higby (1943) states that hesperidin chalcone, but not the flavanone, is adsorbed by charcoal. If a solution containing potent vitamin P be kept in the light, but without contact with air and in a cool place (15–17°), its activity is maintained for 1–2 months. Even at room temperature, however, in the absence of air and in the dark a slow loss of potency occurs (Table 4). It is to be expected, therefore, that the

Table 4. *Loss of vitamin P potency from a preparation of blackcurrants* stored in the dark at approx. 20° in the absence of air*

	P.U./100 g.
Tested Nov./Dec. 1943	600
Tested Feb. 1944	200–300
Tested May 1944	150–200
Tested Sept. 1944	Negligible

* Prepared in late summer 1943.

vitamin P potencies of liquid commercial preparations obtained in the open market will show greater variations than can be accounted for on the basis of experimental error. In Table 5 are given the results

Table 5. *Vitamin P potencies of rose-hip syrups obtained in the open market*

Preparation	Potency (P.U./100 g.)	Preparation	Potency (P.U./100 g.)
A1	500	B3	0
A2	600	C1	100
A3	350	C2	50
B1	500	C3	50
B2	100		

of clinical assays on specimens of rose-hip syrup. Although the necessary data are not available for calculating back to the original fruit, it is unlikely that the variations are to be attributed entirely to differences in potency of the original fruit or to varying concentration of the extracts. They are more likely to be due to losses of potency during preparation and/or storage.

DISCUSSION

The effect of certain material (collectively known as vitamin P) in increasing capillary resistance (decreasing fragility) has now been demonstrated in man, guinea-pig, rat and mouse. The statement often made that citrin is vitamin P is meaningless.

The word 'citrin' is merely an expression of the tendency of flavanone derivatives to crystallize in complexes which 'give relatively sharp melting-points and otherwise resemble pure substance' (Higby, 1943). Crude hesperidin, chemically pure hesperidin flavanone, hesperidin chalcone and the aglycone hesperetin have all been proved active but there is insufficient evidence for, and certain evidence against, the view that hesperidin is vitamin P.

It is presumably an essential property of a vitamin that it be reasonably soluble either in water at, or about, pH 7.0 or in animal fats. Neither hesperidin nor hesperetin fulfil these requirements and therefore neither is vitamin P. They may, however, be precursors of a more active substance, possibly the chalcone, produced in the body following their absorption. This conception would place them with carotene as provitamins but need not be taken to imply that activity is acquired with molecular simplification. In spite of its insolubility it is interesting to note that clinical assays of hesperidin from different sources at different levels of dosage in different subjects have fairly regularly given a potency value of about 100 P.U./g., a value also obtained by guinea-pig assay (Bacharach & Coates, 1942). It seems most unlikely that the high potency of certain water-soluble extracts can be attributed to hesperidin or its chalcone and it may be that vitamin P potency, as assessed by capillary resistance determination, resides in a group of substances which includes certain flavanones. That the question is not entirely one of solubility, however, is indicated by unpublished work reported to the Biochemical Society (Scarborough, 1940) suggesting that potent water-soluble preparations of vitamin P have no direct effect on capillary walls. Although potency does not parallel colour intensity, so that anthocyanins, for example from beetroot, are inactive in increasing capillary resistance (Scarborough, unpublished results), a water-soluble preparation highly potent both in guinea-pigs (the W.S.P. 4 of Bacharach & Coates, 1942) and in man (Table 3) was considered to consist 'largely of glucosides of the anthoxanthin type' (Pollard, 1942). Writing of this material in a private communication to Bacharach & Coates, Dr R. A. Morton in 1942 stated that the material was obviously different from hesperidin on spectroscopic examination. The absorption was found to be of the right order for a single absorbing substance but the spectrum did not closely resemble that associated with flavanols and flavanones (see also Morton, 1942).

SUMMARY

1. The preparation from orange meal, and the characterization, of hesperidin and hesperetin are described. Both these substances increase capillary

resistance in man when given by mouth in aqueous suspension but, for reasons given, neither can be regarded as vitamin P. Hesperidin is more than twice as active as the aglycone. It is unlikely that the preparation of hesperidin contained significant quantities of the chalcone to which its activity has been attributed by Higby (1943).

2. The activity of both hesperidin and hesperetin is exceeded by certain water-soluble extracts, the active principles of which are not at present known.

3. The results of clinical assays of the vitamin P potencies of a number of foods are described. The grape has proved to be the richest natural source. Vitamin P potency does not parallel ascorbic acid content.

4. Vitamin P potency as assessed by capillary resistance determinations in man is destroyed by boiling the active solutions in air or by shaking with charcoal.

5. A slow but gradual loss of vitamin P potency

was observed during storage of a preparation of blackcurrants stored at 20° in the dark in the absence of oxygen. Loss of vitamin P activity is to be expected from fruit preparations (e.g. rose-hip syrup) under ordinary conditions of storage.

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