XXXVII.—6'-*Aminoquercetin*.

By EDWIN ROY WATSON.

QUERCETIN is a natural hydroxy ketonic dye of considerable value on account of its cheapness and the fastness of the shades obtained with it on suitable mordants. Other members of the flavone group are also valuable for similar reasons. The chief limitation of the group seems to lie in the fact that the colour never goes beyond yellow, orange, or brown shades. It seemed, therefore, of interest and value to attempt to prepare derivatives which, whilst retaining the fastness of the original dyes, would yield deeper shades, such as red, violet, or blue.

The first method which suggested itself for fulfilling this object was the introduction of additional auxochrome groups. This method has proved very useful in the alizarin group of dyes and there are many cases where the addition of one or two more auxochromes causes a great deepening of colour (compare brazilein and hæmatein, fluorescein and gallein). There were, certainly, reasons for not expecting too much from the addition of more auxochromes in this group. Myricetin and quercetin have not appreciably deeper shades than luteolin, although they contain two and one additional hydroxyl groups respectively. It could be argued, however, that much might depend on the positions of the auxochromes, thus, anthracene-blue, W.R., 1:2:4:5:6:8-hexahydroxyanthraquinone, dyes blue shades on chrome and rufigallol, 1:2:3:5:6:7-hexahydroxyanthraquinone, gives only brown shades on the same mordant. At any rate, it appeared worth while to introduce an additional auxochrome into quercetin and observe the effect on the colour of the dye. The preparation of a hydroxyquercetin possessed the further interest that it might prove identical with myricetin, gossypetin, or quercetagetin, and thus confirm or help in arriving at the constitutional formulæ of these substances.

By the complete methylation of quercetin to protect the molecule, nitration, reduction, and subsequent demethylation, 6'-*aminoquercetin* was obtained. Attempts to convert the amino-group into a hydroxyl group by diazotisation and boiling with water or dilute acid have not as yet been successful. 6'-Aminoquercetin dyes almost the same shades as quercetin, and its preparation did not thus effect the primary object of this investigation. The subsequent investigation of quercetagetin and gossypetin (A. G. Perkin, T., 1913, **103**, 209, 650) seems to show that the multiplication of auxochrome groups, whatever positions they may occupy, will not appreciably deepen the colour in this group of dyes.

Further work on somewhat different lines has been more successful and has resulted in the preparation of derivatives of quercetin which dye violet and blue shades. These will be described in a subsequent communication.

In the course of this investigation, several oxonium salts of quercetin pentamethyl ether were isolated, namely, the *hydrochloride*, $C_{20}H_{20}O_7 \cdot HCl$, the *hydrobromide*, $C_{20}H_{20}O_7 \cdot HBr$, the *sulphate*, $C_{20}H_{20}O_7 \cdot H_2SO_4$, and the *nitrate*, $C_{20}H_{20}O_7 \cdot HNO_3$; also *dibromoquercetin pentamethyl ether hydrobromide*, $C_{20}H_{18}O_7Br_2 \cdot HBr$. These compounds are all of a bright yellow colour and easily prepared. Their formation was rather unexpected, as, although quercetin itself readily gives such bright yellow oxonium salts, progressive methylation seems to reduce the tendency to form compounds of this character. Rhamnetin and rhamnazin yield sulphates with difficulty, but no compounds with the halogen acids (A. G. Perkin, T., 1896, **69**, 1439) and quercetin tetramethyl ether only forms a very unstable sulphate. Their bright yellow colour indicates that they should be assigned a quinonoid structure such as:

These compounds seem somewhat comparable with the hydrochloride of fluorescein diethyl ether which is of an intense yellow colour and decomposed by water (Nietzki and Schröter, *Ber.*, 1895, **28**, 50), and most, if not all, become bright red on the surface if left exposed to the air, although, for the present, no explanation of this behaviour can be offered.

EXPERIMENTAL.

Preparation of Quercetin Pentamethyl Ether.—This was effected by a modification of Valiaschko's process (*Arch. Pharm.*, 1904, **242**, 242; *Ber.*, 1909, **42**, 727). Herzig and Hofmann's simpler process (*Ber.*, 1909, **42**, 155) was tried without success. In preparing quercetin trimethyl ether from quercetin by treatment with potassium hydroxide and methyl sulphate in methyl-alcoholic solution, it was found necessary to add the methyl sulphate and then the alcoholic potassium hydroxide as quickly as possible to the boiling solution, instead of gradually, as recommended by Valiaschko. For the later stage of the process, namely, conversion of the trimethyl ether into the pentamethyl ether through the potassium

salt, it was found necessary to leave a little excess of potassium hydroxide in contact with the potassium salt.

6'-Nitroquercetin Pentamethyl Ether, $C_{15}H_4O_2(OMe)_5 \cdot NO_2$.—Five grams of finely-powdered quercetin pentamethyl ether were added gradually to 50 c.c. of cold nitric acid (D 1.4 which had been boiled with carbamide nitrate), in which it dissolved to a clear yellow-brown solution. This was poured slowly into $2\frac{1}{2}$ litres of cold water, kept stirring, and the mixture was then boiled until the gelatinous precipitate changed into bright yellow, needle-shaped crystals. After cooling, the crystals (5.15 grams) were collected, washed with water, and dried. The substance may be rendered pure by one or two recrystallisations from acetone, from which solvent it is deposited in golden-yellow, needle-shaped crystals melting at $202-204^\circ$. It can also be conveniently crystallised from ethyl alcohol, methyl alcohol, ethyl acetate, or benzene; is very soluble even in cold chloroform or acetic acid; and is insoluble in ether, carbon disulphide, or light petroleum. It dissolves in cold sulphuric acid to a deep reddish-brown solution and is precipitated unchanged on pouring this solution into water.

0.1134 gave 0.2405 CO_2 and 0.0463 H_2O . $C=57.83$; $H=4.53$.

0.1487 „ 4.7 c.c. N_2 (moist) at 14° and 769 mm. $N=3.76$.

0.1516 „ 0.4187 AgI. $Me=17.61$.

$C_{20}H_{19}O_9N$ requires $C=57.55$; $H=4.55$; $N=3.35$;

$Me=17.98$ per cent.

The above-described method of nitration is the only one by which a good yield of the mononitro-compound has yet been obtained. In small quantity (up to 10 per cent.), together with oxidation products, it was formed by the action of boiling dilute aqueous nitric acid on quercetin pentamethyl ether or by nitrating this substance in the cold in glacial acetic acid solution.

6'-Aminoquercetin Pentamethyl Ether, $C_{15}H_4O_2(OMe)_5 \cdot NH_2$.—The preceding nitro-compound was readily reduced by tin and alcoholic hydrochloric acid, yielding the hydrochloride of 6'-aminoquercetin pentamethyl ether. Five grams of the finely-powdered mononitro-compound were mixed with 150 c.c. of alcohol, 15 c.c. of concentrated hydrochloric acid and 5 grams of finely granulated tin, and the mixture kept nearly boiling. After some time, another 15 c.c. of hydrochloric acid and 5 grams of tin were added. In about two hours, reduction was complete, and the fine, white, needle-shaped crystals produced were collected, dried, and dissolved in 2 litres of boiling water to which a little dilute hydrochloric acid had been added. The solution was filtered hot and treated at once with sodium carbonate solution until alkaline, which precipitated the free base as a sandy deposit of rhombic crystals. 3.5 Grams

were thus obtained, being a yield of 70 per cent. on the weight of nitro-compound taken. No further quantity could be isolated by working up the mother liquors.

The substance can be purified by recrystallisation from benzene, from which solvent it is deposited in white, stout, heavy prisms, melting at 200—202°. It can also be conveniently crystallised from hot ethyl or methyl alcohol, acetone, or ethyl acetate. It is very soluble even in cold chloroform, but practically insoluble in ether, light petroleum, or carbon disulphide.

0.1095 gave 0.2493 CO₂ and 0.0534 H₂O. C=62.09; H=5.41.

0.1353 „ 4.7 c.c. N₂ (moist) at 30° and 758 mm. N=3.7.

0.1523 „ 0.4553 AgI. Me=19.06.

C₂₀H₂₁O₇N requires C=62.01; H=5.42; N=3.61;

Me=19.37 per cent.

6'-Aminoquercetin Pentamethyl Ether Hydrochloride,

C₁₅H₄O₂(OMe)₅·NH₂·HCl.

—This substance was obtained in fine, white, needle-shaped crystals in the reduction of nitroquercetin pentamethyl ether. It was also prepared by boiling the free base with dilute hydrochloric acid. On cooling the solution, fine, white, needle-shaped crystals were deposited, which were collected and dried in a vacuum over soda-lime, when they melted and decomposed at 245—247°. The pure dry compound dissolves in cold water, owing to decomposition of the salt and the formation of a pseudo-solution of the base, but, after a short time, crystals of the free base are deposited.

0.4886 was neutralised by 11.2 c.c. N/10-KOH; HCl=8.37.

C₂₀H₂₁O₇N·HCl requires HCl=8.61 per cent.

6'-Aminoquercetin Pentamethyl Ether Sulphate,

C₁₅H₄O₂(OMe)₅·NH₂·H₂SO₄

—This salt was prepared by dissolving the free base in boiling dilute sulphuric acid (1:20). On cooling the solution, white, needle-shaped crystals separated, which melted and decomposed at 245—247°.

0.2020 was neutralised by 8.2 c.c. N/10-KOH; H₂SO₄=19.89.

C₂₀H₂₁O₇N·H₂SO₄ requires H₂SO₄=20.20 per cent.

6'-Diacetylaminquercetin Pentamethyl Ether,

C₁₅H₄O₂(OMe)₅·NAc₂.

—Aminoquercetin pentamethyl ether was boiled with excess of acetic anhydride for several hours. The solution was then filtered hot and, after the addition of alcohol, evaporated on the water-bath. The residue, which almost immediately became solid, was recrystallised from alcohol. If necessary, the whole process was repeated. The substance crystallises in white prisms, melts at 185°,

is readily soluble in acetic acid, but less so in alcohol. It has an exceedingly bitter taste, whilst neither pentacetylquercetin, heptacetylaminquercetin, nor quercetin pentamethyl ether possesses this property.

0.1249 gave 0.2809 CO_2 and 0.0596 H_2O . $\text{C}=61.34$; $\text{H}=5.30$.

0.1990 „ 5.8 c.c. N_2 (moist) at 28° and 759 mm. $\text{N}=3.19$.

0.2716 „ 11.6 c.c. $\text{N}/10$ -acetic acid; $\text{C}_2\text{H}_4\text{O}_2=25.6$.

$\text{C}_{24}\text{H}_{25}\text{O}_9\text{N}$ requires $\text{C}=61.1$; $\text{H}=5.3$; $\text{N}=2.9$;

$\text{C}_2\text{H}_4\text{O}_2=25.5$ per cent.

Incomplete acetylation gave also another substance, less soluble in alcohol and precipitated on adding alcohol to the acetylation mixture. This melts at $223\text{--}226^\circ$ (see P., 1911, 27, 163) and is probably *monoacetylaminquercetin pentamethyl ether*,

$\text{C}_{15}\text{H}_4\text{O}_2(\text{OMe})_5\cdot\text{NHAc}$.

6'-Aminoquercetin Hydriodide, $\text{C}_{15}\text{H}_4\text{O}_2(\text{OH})_5\cdot\text{NH}_2\cdot\text{HI}$.—This substance was isolated as the chief product in demethylating 6'-aminoquercetin pentamethyl ether with hydriodic acid. The same reagent effected the simultaneous reduction and demethylation of 6'-nitroquercetin pentamethyl ether and there was no advantage in isolating the intermediate aminopentamethyl ether. Five grams of 6'-nitroquercetin pentamethyl ether were gently boiled for an hour with 150 c.c. of hydriodic acid (D 1.7). Then the mixture was boiled vigorously until most of the hydriodic acid was distilled off and only 10—15 c.c. remained. Water was added to the residue, making the bulk up to 750 c.c., sulphur dioxide was passed in until all free iodine was destroyed, the mixture was boiled and filtered hot to remove a little insoluble matter, and the bright orange-red filtrate was concentrated. On cooling, aminoquercetin hydriodide separated in orange-coloured nodules, was collected, washed with a little aqueous sulphur dioxide, and dried. Three grams of the deep orange hydriodide were thus obtained. Attempts to isolate a further quantity by concentrating the mother liquor were unsuccessful, and it was found advisable, in later preparations, to work up the mother liquor to give the remainder of the aminoquercetin as hydrochloride. 6'-Aminoquercetin hydriodide is fairly soluble in hot dilute hydrochloric acid, but much less so in the cold. It is partly decomposed on boiling with water.

6'-Aminoquercetin Hydrochloride, $\text{C}_{15}\text{H}_4\text{O}_2(\text{OH})_5\cdot\text{NH}_2\cdot\text{HCl}$.—For the preparation of this salt, 6'-nitroquercetin pentamethyl ether was boiled with hydriodic acid for an hour as described in the preceding paragraph. The product was then poured into nine times its bulk of water, freed from iodine by sulphur dioxide or a slight excess of sodium hydrogen sulphite solution, filtered to remove a certain amount of insoluble matter, and treated with excess of solid

sodium acetate. The sodium acetate produced a bulky, gelatinous, yellow precipitate of a sodium salt of aminoquercetin, and this was collected and washed with cold water as rapidly as possible. The precipitate must not be allowed to remain in the air or it will be partly oxidised to dark-coloured products. It was then dissolved in boiling dilute hydrochloric acid (1 part of hydrochloric acid to 12 parts of water) and the solution concentrated. On cooling, aminoquercetin hydrochloride was deposited in buff-yellow, fine, needle-shaped crystals in radiate aggregates, which were collected, washed two or three times with small quantities of cold dilute hydrochloric acid, and dried in the steam-oven, care being taken not to break up the cake or expose a larger surface than possible to the air while moist. For purification, it was recrystallised from dilute hydrochloric acid, avoiding any unnecessary oxidation. When free from oxidation products, aminoquercetin hydrochloride is of a buff-yellow colour, and readily soluble in hot dilute hydrochloric acid, but much less so in the cold. It does not melt even at 330°. On boiling the dry salt with water, it is partly decomposed.

0.1150 gave 4.0 c.c. N_2 (moist) at 18° and 755 mm. $N=3.98$.

$C_{15}H_{11}O_7N.HCl$ requires $N=3.96$ per cent.

The most successful preparations gave 60 per cent. of aminoquercetin hydrochloride, reckoned on the weight of the nitro-pentamethyl ether taken.

6'-Aminoquercetin Sulphate, $C_{15}H_4O_2(OH)_5.NH_2.H_2SO_4$.—On substituting dilute sulphuric acid for hydrochloric acid in the preceding preparation, there was obtained aminoquercetin sulphate in buff-yellow nodules or warts. A quantity of sulphate was also obtained from the hydrolysis of hepta-acetylaminoquercetin by sulphuric acid in alcohol and, on adding warm water and allowing to remain, the sulphate was deposited in aggregates of fine needles. It melts and decomposes at 222—227°:

0.1314 gave 3.8 c.c. N_2 (moist) at 30° and 756 mm. $N=3.12$.

$C_{15}H_{11}O_7N.H_2SO_4$ requires $N=3.37$ per cent.

6'-Aminoquercetin, $C_{15}H_4O_2(OH)_5.NH_2$.—Only the following method was found successful for the liberation of the free base from the above-mentioned salts:—To one gram of the dry salt (hydrochloride or hydriodide) were added 15 c.c. of pyridine and 30 c.c. of hot water and the mixture was kept just on the point of boiling. After a short time, crystals began to appear, chiefly at the surface of the liquid and on the sides of the flask above the liquid, and these, on keeping, increased in quantity. Forty-five c.c. of boiling absolute alcohol were now added, the mixture once more brought to the boiling point and allowed to cool, and the crystals which

separated were at once collected, washed with absolute alcohol, and dried. From 1 gram of the hydriodide, only about 0.3 gram of the base was obtained. 6'-Aminoquercetin consists of buff-yellow, fine, needle-shaped crystals, almost insoluble in alcohol, acetone, chloroform, ethyl acetate, phenol, or nitrobenzene. No suitable solvent for its recrystallisation was discovered. It does not melt, but blackens and decomposes about 320°.

The following analyses were carried out with the substance dried at 150°:

0.1171 gave 0.2434 CO₂ and 0.0401 H₂O. C=56.68; H=3.80.

0.1066 „ 4.4 c.c. N₂ (moist) at 24° and 760 mm. N=4.62.

C₁₅H₁₁O₇N requires C=56.78; H=3.47; N=4.41 per cent.

Position of the Amino-group in Aminoquercetin.—This was determined, indirectly, by ascertaining the position of the nitro-group in the nitroquercetin pentamethyl ether from which aminoquercetin is obtained. The nitro-pentamethyl ether was oxidised by potassium permanganate and gave 6-nitroveratric acid,

as one of the products. Four grams of the nitro-pentamethyl ether were dissolved in cold sulphuric acid and reprecipitated by pouring the solution into a large volume of water. The substance was thus obtained in a finely-divided, amorphous condition. After washing, it was rubbed into a paste with a cold aqueous solution of 10 grams of potassium permanganate and allowed to remain over-night. By the next morning the pink colour of the permanganate had completely disappeared. The precipitated manganese dioxide was filtered off, the filtrate acidified with hydrochloric acid, and extracted with ether. On spontaneous evaporation, the ethereal extract left a yellow oil which quickly solidified. This was recrystallised from benzene and found to be 6-nitroveratric acid (*Ber.*, 1876, **9**, 938).

Dyeing Properties of 6'-Aminoquercetin.—Full dyeings of the following shades were obtained on wool with 4 per cent. of the dye-stuff (reckoned on the weight of the wool): pure brown on chrome, yellowish-brown on alum, orange-red on tin, and brownish-black on iron. The shades on chrome and alum were browner, on tin redder and deeper, than those obtained by comparative tests with quercetin.

Hepta-acetyl-6'-aminoquercetin, C₁₅H₄O₂(OAc)₅·NAc₂.—This characteristic derivative of aminoquercetin was obtained from the free base or its salts by boiling with acetic anhydride for an hour.

The acetyl derivative was precipitated in crystalline form by adding alcohol. For purification, it was again dissolved in acetic anhydride, boiled for half-an-hour, and precipitated by alcohol. The acetylation of the hydrochloride was effected by boiling together for one and a-half hours 1 gram of the well-dried hydrochloride, 1 gram of fused sodium acetate, and 5 c.c. of acetic anhydride. An equal volume of glacial acetic acid was then added and the mixture poured into excess of water. The acetyl derivative was precipitated as a white, amorphous powder, which was collected, dried, and purified by dissolving in acetic anhydride, boiling for half-an-hour, and precipitating by alcohol. By either method, it was obtained in white, rhombic crystals, melting at 151—153°, sparingly soluble in alcohol, readily so in glacial acetic acid or acetic anhydride. This derivative serves to characterise 6'-aminoquercetin :

0.1275 gave 0.2671 CO_2 and 0.0510 H_2O . $\text{C}=57.12$; $\text{H}=4.44$.

0.2033 „ 4.5 c.c. N_2 (moist) at 21° and 755 mm. $\text{N}=2.50$.

0.4967 „ 56.9 c.c. $\text{N}/10$ -acetic acid = 68.7.

$\text{C}_{29}\text{H}_{25}\text{O}_{14}\text{N}$ requires $\text{C}=56.95$; $\text{H}=4.09$; $\text{N}=2.29$;

$\text{C}_2\text{H}_4\text{O}_2=68.7$ per cent.

If acetylation has not been complete, there is also formed another substance melting above 200° which is probably the hexa-acetyl derivative.

Quercetin Pentamethyl Ether Diazonium Chloride,

One gram of finely-powdered 6'-aminoquercetin pentamethyl ether was treated with 10 c.c. of water and 2.8 c.c. of concentrated hydrochloric acid, warmed and mixed thoroughly to convert the base entirely into hydrochloride. On adding 9 c.c. of a solution of sodium nitrite (1:50) to the cooled mixture, the stiff, white paste of hydrochloride became yellow and passed almost entirely into solution. On scratching the sides of the tube, the diazonium chloride was precipitated as yellow needles. After two hours, these were collected, washed with benzene and dried on a porous tile, and afterwards over soda-lime in a desiccator. This substance is readily soluble in cold water or dilute hydrochloric acid and in alcohol. From solution in the latter medium, it can be precipitated in the crystalline form by ether. Its solution in water or dilute hydrochloric acid gives at once a crimson precipitate with an alkaline solution of β -naphthol. The aqueous solution is fairly stable and gives the diazo-reaction, even after a few minutes' boiling.

The solid, on keeping in the air, becomes red on the surface. When heated in the steam-oven, it loses most of its nitrogen:

(1) 0.1376 gave 7.1 c.c. N_2 (moist) at 19° and 749 mm. $N=5.84$.

(2) 0.1520 „ 8.2 c.c. N_2 (moist) at 30° and 755 mm. $N=5.81$.

$C_{20}H_{19}O_7N_2Cl$ requires $N=6.44$ per cent.

[Sample (2) was purified by solution in alcohol and re-precipitation with ether.]

Quercetin Pentamethyl Ether Diazonium Sulphate,

—This substance was gradually precipitated in short, needle-shaped crystals on the addition of dilute sulphuric acid (1:4) to a cold saturated aqueous solution of the diazonium chloride:

0.1520 gave 6.9 c.c. N_2 (moist) at 30° and 756 mm. $N=4.90$.

$C_{20}H_{20}O_{11}N_2S$ requires $N=5.64$ per cent.

6'- β -Naphtholazoquercetin Pentamethyl Ether,

—One gram of 6'-aminoquercetin pentamethyl ether was diazotised as described in the preparation of the diazonium chloride, water (about 100 c.c.) was then added until all the diazonium chloride had dissolved, and this liquid was added gradually to a solution of 0.4 gram of β -naphthol and 1.9 grams of potassium hydroxide in 50 c.c. of water. The gelatinous, crimson precipitate was collected, washed, dried, and recrystallised from glacial acetic acid, from which solvent it was deposited in needle-shaped, crimson crystals, melting and decomposing at $222-225^\circ$ (compare P., *loc. cit.* The sample melting at 211° was not pure). It is fairly soluble in alcohol, insoluble in aqueous alkalis, and dissolves in sulphuric acid with an indigo-blue colour:

0.1521 gave 7.1 c.c. N_2 (moist) at 29° and 758 mm. $N=5.09$.

$C_{30}H_{26}O_8N_2$ requires $N=5.16$ per cent.

Trinitroquercetin Pentamethyl Ether (?), $C_{15}H_2O_2(OMe)_5(NO_2)_3$.

When quercetin pentamethyl ether was dissolved in cold fuming nitric acid and the solution poured into water, there was precipitated a canary-yellow substance which, on boiling the mixture, became granular. This substance, after filtering and washing, was treated with dilute aqueous ammonia, when a considerable portion dissolved, forming a brownish-red solution. The residue, on analysis, was found to contain a percentage of nitrogen corresponding nearly with trinitroquercetin pentamethyl ether. Attempts to recrystallise this compound were not successful. It was scarcely soluble in alcohol, acetone, benzene, or acetic acid, but was readily so in nitrobenzene, and melted at $190-205^\circ$:

0.0652 gave 4.9 c.c. N_2 (moist) at 14° and 761 mm. $N=8.86$.

$C_{20}H_{17}O_{13}N_3$ requires $N=8.28$ per cent.

Dibromoquercetin Pentamethyl Ether Hydrobromide,
 $C_{15}H_3O_2(OMe)_5Br_2.HBr$.*

This oxonium salt was obtained by brominating quercetin pentamethyl ether either in glacial acetic acid or in carbon disulphide solution, for example, 2.5 grams of the pentamethyl ether were dissolved in 20 c.c. of glacial acetic acid and to this solution, when cold, were added, gradually, 2.2 grams of bromine (2 mols.) also dissolved in about 20 c.c. of glacial acetic acid. At once a deep crimson liquid and precipitate were formed, which soon, however, became light yellow. When the whole of the bromine had been added, the mixture soon became a semi-solid, bright yellow mass of fine, needle-shaped crystals. It was thoroughly stirred at intervals and after keeping over-night the precipitate was collected and washed with acetic acid.

Dibromoquercetin Pentamethyl Ether, $C_{15}H_3O_2(OMe)_5Br_2.EtOH$.—The oxonium hydrobromide prepared as above was, without drying, treated with about 50 c.c. of alcohol which turned the surface of the mass crimson. On warming, the whole dissolved, and, on cooling, the solution deposited about 1.5 grams of the new substance in almost colourless crystals. It was purified by recrystallisation from benzene, which did not eliminate the molecule of ethyl alcohol. It is readily soluble in hot alcohol, still more so in hot benzene, and crystallises in prisms which, when deposited from benzene, are short, and arranged in sheaves. It melts at $173-175^\circ$:

0.1255 gave 0.2119 CO_2 and 0.0467 H_2O ; $C=46.04$; $H=4.13$.

0.2507 „ 0.1640 $AgBr$. $Br=27.84$.

$C_{22}H_{24}O_8Br_2$ requires $C=45.84$; $H=4.16$; $Br=27.77$ per cent.

As quercetin was produced by the demethylation of this substance with hydriodic acid, it could not be dibromoethoxyquercetin pentamethyl ether.

Monobromoquercetin Pentamethyl Ether, $C_{15}H_4O_2(OMe)_5Br$.—This was obtained by boiling dibromoquercetin pentamethyl ether hydrobromide with water. From each molecule of the oxonium hydrobromide approximately two molecules of monobasic acid were liberated, perhaps in accordance with the equation:

* This and the following bromo-derivatives were prepared with the idea that they might be more readily nitrated than quercetin pentamethyl ether; the successful preparation of nitroquercetin pentamethyl ether rendered their use, however, unnecessary.

A sample of the oxonium hydrobromide, carefully washed with acetic acid, was dried on a porous tile and finally, for several days, over soda-lime in a vacuum desiccator, being removed from time to time, finely powdered and replaced in the desiccator. After boiling with water, 0.3887 gram gave 11.2 c.c. *N*/10-acid, whilst the above equation requires 12.7 c.c.

The insoluble product was recrystallised from benzene or alcohol and obtained in needles melting at 215°. It was of a light cream colour and was not readily soluble in either of the above-mentioned solvents.

The same substance was obtained directly by the bromination of quercetin pentamethyl ether in acetic acid solution in the presence of fused sodium acetate: 1 gram of the pentamethyl ether was brominated as in the preparation of the dibromo-oxonium hydrobromide, except that 1.5 grams of fused sodium acetate were dissolved with the pentamethyl ether in acetic acid before the bromine was added. A cream-coloured precipitate of apparently uniform needles was at once obtained. After remaining over-night, the precipitate (0.65 gram) was collected, washed with acetic acid, and recrystallised from benzene.

0.1217 gave 0.2345 CO₂ and 0.0438 H₂O. C=52.88; H=4.08.

0.2522 „ 0.1054 AgBr. Br=17.80.

C₂₀H₁₉O₇Br requires C=53.21; H=4.21; Br=17.75 per cent.

Dibromonitroquercetin Pentamethyl Ether (?),

One gram of dibromoquercetin pentamethyl ether was dissolved in cold nitric acid (D 1.4) and the solution poured into water. The precipitate was collected, recrystallised from alcohol, and again from acetone, and was thus obtained in rhombic crystals of a pale yellow colour melting at 173—175°:

0.1072 gave 2.4 c.c. N₂ (moist) at 14° and 773 mm. N=2.67.

C₂₀H₁₇O₉NBr₂ requires N=2.43 per cent.

The peculiar behaviour of dibromoquercetin pentamethyl ether makes it unwise, however, to definitely assign the above formula to this compound without further analysis.

Quercetin Pentamethyl Ether Oxonium Salts, C₂₀H₂₀O₇.HCl;
C₂₀H₂₀O₇.HBr; C₂₀H₂₀O₇.H₂SO₄; and C₂₀H₂₀O₇.HNO₃.

The first three of these oxonium salts were prepared by dissolving the pentamethyl ether in glacial acetic acid and adding the corresponding acids in a concentrated form, and separated in yellow, needle-shaped crystals. They were collected, washed with glacial

acetic acid, dried on a porous tile, and finally over soda-lime in a vacuum, being once or twice finely powdered to expose a fresh surface. The sulphate could be dried in the steam-oven without decomposition. These substances were analysed by boiling with water, filtering, and titrating the filtrate:

0.3471 hydrochloride gave 8.5 c.c. *N*/10-acid; $\text{HCl} = 8.9$.

$\text{C}_{20}\text{H}_{20}\text{O}_7, \text{HCl}$ requires $\text{HCl} = 8.9$ per cent.

0.4240 hydrobromide (still containing a trace of acetic acid) gave 10.6 c.c. *N*/10-acid, and 0.1672 AgBr ; $\text{HBr} = 17.41$.

$\text{C}_{20}\text{H}_{20}\text{O}_7, \text{HBr}$ requires $\text{HBr} = 17.88$ per cent.

0.2904 sulphate gave 12.2 c.c. *N*/10-acid; $\text{H}_2\text{SO}_4 = 20.6$.

$\text{C}_{20}\text{H}_{20}\text{O}_7, \text{H}_2\text{SO}_4$ requires $\text{H}_2\text{SO}_4 = 20.85$ per cent.

All these salts showed a tendency to develop a red colour; the hydrochloride and hydrobromide became red on the surface when left on the tile, and the sulphate became salmon-coloured when heated to 100° .

The *nitrate* was prepared by adding concentrated nitric acid in the cold to a solution of quercetin pentamethyl ether in glacial acetic acid in the presence of carbamide nitrate, but, in this way, could not be freed from carbamide nitrate. It was also obtained by adding concentrated nitric acid to a cold solution of quercetin pentamethyl ether in absolute alcohol and separated as a bright yellow precipitate of needle-shaped crystals. It was collected and at once dried on a porous tile and over soda-lime in a vacuum. It could not be washed with alcohol without decomposition, nor with acetic acid as, in this medium, in the absence of carbamide nitrate, it is at once attacked by the nitric acid with the liberation of nitrous fumes:

0.2433 (dried without washing) gave 7.6 c.c. *N*/10-acid; $\text{HNO}_3 = 19.6$.

0.2541 (washed with alcohol) gave 5.1 c.c. *N*/10-acid; $\text{HNO}_3 = 12.6$.

$\text{C}_{20}\text{H}_{20}\text{O}_7, \text{HNO}_3$ requires $\text{HNO}_3 = 14.4$ per cent.

In conclusion, I wish to express my very great indebtedness to Mr. A. G. Perkin, F.R.S., who pointed out to me the advantages of choosing quercetin as a starting point for researches such as I had in view, and who has, throughout the work here described, assisted me by continual advice and guidance.

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