gan separating, and the mixture was chilled to ice-bath temperature to give 9.8 mg. (90% yield) of white crystals, m.p. 286–288° dec. (darkened from 270°), after recrystallization from 2-methoxyethanol. A mixture of this material with an authentic sample melted at 287–289° dec. after prior darkening. This material had $[\alpha]^{25}D$ +121° (c 0.49, chloroform) and its entire infrared spectrum was identical with that of an authentic specimen.

PEARL RIVER, N. Y.

[CONTRIBUTION FROM THE MERCK SHARP & DOHME RESEARCH LABORATORIES, DIVISION OF MERCK & CO., INC.[a] AND THE DEPARTMENTS OF MICROBIOLOGY, BIOCHEMISTRY AND PEDIATRICS, SCHOOL OF MEDICINE, UNIVERSITY OF PENNSYLVANIA[b]]

The Structure of a New Product from Yeast: 2-(6-Hydroxy-2-methoxy-3,4-methylenedioxyphenyl)-benzofuran

BY M. A. P. MEISINGER,[a] FREDERICK A. KUEHL, JR.,[a] E. L. RICKES,[a] NORMAN G. BRINK[a] AND KARL FOLKERS[a] AND MARTIN FORBES,[b] FRIEDERICH ZILLIKEN[b] AND PAUL GYORGY[b]

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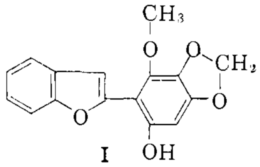
A new crystalline compound from yeast has been shown to be 2-(6-hydroxy-2-methoxy-3,4-methylenedioxyphenyl)-benzofuran (I).

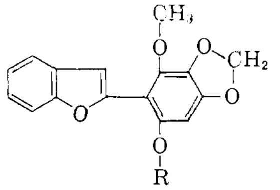
The isolation from yeast of a new crystalline compound has been described by Forbes, Zilliken, Roberts and Gyorgy.[1] It was reported to be an antioxidant, and to be highly active in tests involving the inhibition of hemolysis of red cells. It was characterized as a colorless, solvent-soluble, optically inactive aromatic compound of the composition $C_{16}H_{12}O_5$. We have repeated the isolation and wish to present new studies on the degradation of this substance to products of proven structure[2] which led to the elucidation of the substance as 2 - (6 - hydroxy - 2 - methoxy - 3,4 - methylenedioxyphenyl)-benzofuran (I).

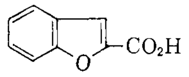

I

The initial studies[1] on this new substance showed the presence of one methoxyl group by a Zeisel determination, and a second methoxyl group was introduced by reaction of the compound with diazomethane; thus, the presence of a free phenolic hydroxyl group was indicated.

In this Laboratory, reaction of this substance with dimethyl sulfate in alkali gave in better yield the same methyl derivative II. Confirmation of the presence of a free hydroxyl group was obtained by acetylation to the monoacetyl derivative III. Evidence for the presence of a methylenedioxy group was obtained by hydrolysis with 90% sulfuric acid. The formaldehyde produced was detected by its color reaction with chromatropic acid.[3]

The fifth oxygen atom in the molecule was presumed to be a member of a nucleus, and this interpretation was established readily. Oxidation of the molecule with sodium chromate in glacial acetic acid resulted in the formation of coumarilic acid (IV). Alkaline fusion of the substance resulted in extensive decomposition, but some salicylic acid was isolated from the reaction products. The salicylic acid is *corollarial* in structural proof to the coumarilic acid. The initial studies on alkali fusion[1] led to actual recovery of the molecule in 50% yield, but a low yield of an impure and unidentified acid was obtained.


II, R = CH_3
III, R = $COCH_3$
XI, R = C_2H_5
XVIII, R = Ts


IV

These degradation reactions taken in conjunction with the other evidence made it apparent that the substance contains a benzofuran ring substituted in the 2-position and that this 2-substituent is a benzene ring bearing a phenolic hydroxyl, a methoxyl and a methylenedioxy group.

A nuclear magnetic resonance spectrum[4] was determined. Chemical shifts of 35, 50, 100 and approximately zero cycles were observed relative to benzene with relative intensities, respectively, of 1:2:3:5–6. These data suggested the presence of a phenolic hydroxyl group (35 cycles), a methylenedioxy group (50 cycles), a methoxyl group (100 cycles) and a benzene ring or rings (zero cycles) containing about five protons. These interpretations are in accord with structure I.

The methyl derivative II was used in a number of fruitless attempts to degrade the compound to a substituted benzoic acid in order to establish the positions of the oxygen substituents in the unelucidated portion of the molecule. Thus, oxidations with either permanganate or chromate did not destroy the benzofuran portion of this methyl derivative. Instead, the highly oxygenated benzene ring was attacked, and coumarilic and salicylic acids were isolated.

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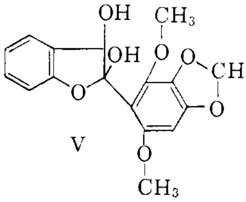
[1] M. Forbes, F. Zilliken, G. Roberts and P. Gyorgy, THIS JOURNAL, **80**, 385 (1958).

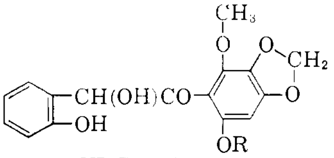
[2] A. F. Wagner, E. Walton, A. N. Wilson, J. O. Rodin, F. W. Holly, N. G. Brink and K. Folkers, *ibid.*, **81**, 4983 (1959).

[3] E. Eegriwe, *Z. anal. Chem.*, **110**, 22 (1937).

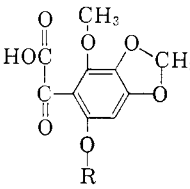
[4] We are indebted to Dr. Joseph Shoolery, Varian Associates, Palo Alto, Calif., for this measurement and interpretation.

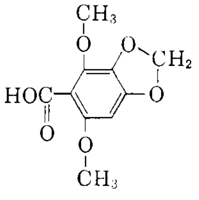
Osmium tetroxide reacted slowly and specifically at the 2- and 3-positions of the methyl derivative II to yield, presumably, the glycol V. This product was not isolated, since it rearranged under the influence of alkali to a yellow crystalline compound which, on the basis of its ultraviolet and infrared absorption spectra, is considered to be 2,6-dimethoxy-3,4-methylenedioxy-2′-hydroxybenzoin (VI).

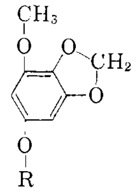

V

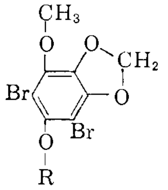

VI, $R = CH_3$
XII, $R = C_2H_5$

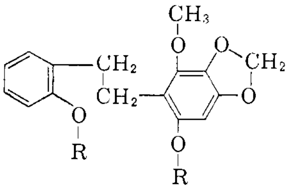
This substituted benzoin VI was resistant to periodate, but potassium permanganate in acetone solution at room temperature selectively oxidized the phenolic ring to give the glyoxylic acid VII. This compound was converted in good yield to the corresponding benzoic acid VIII by treatment with lead tetraacetate. Both the glyoxylic acid VII and the benzoic acid VIII on pyrolysis gave a low-melting dimethoxymethylenedioxybenzene IX which was further characterized by conversion to the crystalline dibromo derivative X.


VII, $R = CH_3$
XIII, $R = C_2H_5$


VIII


IX, $R = CH_3$
XIV, $R = C_2H_5$


X, $R = CH_3$
XV, $R = C_2H_5$


XVI, $R = H$
XVII, $R = COCH_3$

Neither the glyoxylic acid, the benzoic acid nor the dimethoxymethylenedioxybenzene appeared to be known compounds.[5] After certain structures were eliminated from consideration by reference to the literature, the degradation product IX was identified as 1,5-dimethoxy-2,3-methylenedioxybenzene[5] by comparison of its crystalline dibromo derivative X with a sample prepared by an unambiguous synthetic route.[2]

The position of the free hydroxyl group relative to the methylenedioxy and the methoxyl groups in the substance remained to be established, as did the position of the substituted benzene ring at which the benzofuran nucleus was attached. The free hydroxyl group was labeled by preparation of the ethyl derivative XI. This compound when degraded by the same series of reactions previously applied to the methyl derivative II yielded, successively, 6-ethoxy-2-methoxy-3,4-methylenedioxy-2′-hydroxybenzoin (XII), 6-ethoxy-2-methoxy-3,4-methylenedioxyphenylglyoxylic acid (XIII) and finally 5-ethoxy-1-methoxy-2,3-methylenedioxybenzene (XIV) and its dibromo derivative XV. The intermediate compounds XII, XIII and XIV of this series were not completely characterized because of lack of material. The last compound, XV, was identified by direct comparison with a synthetic specimen.[2]

The final question to be settled concerned the point of attachment of the benzofuran to the benzene ring. The answer depended upon the knowledge of the location of the carboxyl group in the substituted benzoic acid VIII; only two structures were possible. Of these, that of 2,6-dimethoxy-3,4-methylenedioxybenzoic acid (VIII) was found to be correct by comparison of the degradation product with a synthetic sample of known structure.[2] Accordingly, formula I has been assigned to this new substance from yeast.

During the course of the degradative studies, we attempted in various ways to reduce the number of possible isomeric structures under consideration for the new substance and the products derived from it. Thus, it was hoped that a series of reactions including a reductive cleavage of the methylenedioxy group might lead to a known dimethoxydihydroxybenzoic acid. In model studies, the methylenedioxy group of piperonylic acid was cleaved with Raney nickel amalgam and alkali under the conditions described by Schwenk and Papa,[6] but as the substitution in the benzene ring increased, little or no reductive cleavage occurred. Apiolic acid, 2,5-dimethoxy-3,4-methylenedioxybenzoic acid, was recovered unchanged after this treatment.

When the new substance itself was treated with Raney nickel catalyst in boiling ethanol, a new compound was obtained. This product has been assigned the structure of 1-(2-hydroxyphenyl)-2-(2-hydroxy-6-methoxy-4,5-methylenedioxyphenyl)-ethane (XVI) on the basis of composition, the presence of a methylenedioxy group,[3] and its conversion to a diacetyl derivative XVII. This catalytic reaction may be of general application, since coumarilic acid (IV) was converted in the same way and in good yield to β-(*o*-hydroxyphenyl)-propionic acid.[7] The same transformation of coumarilic acid was reported previously[7] using Raney nickel amalgam and alkali.

An alternative approach to the preparation of a known degradation product involved the attempted reductive cleavage of the tosyl derivative XVIII. The tosylate was readily prepared, but was recovered unchanged after attempted hydrogenation

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(5) Since the completion of this work, the previously unknown 1,5-dimethoxy-2,3-methylenedioxybenzene (IX) was isolated as a degradation product of the isoflavone, tlatlancuayin by P. Crabbé, P. R. Leeming and C. Djerassi, THIS JOURNAL, **80**, 5258 (1958). The structure of IX as proved in this Laboratory by degradation and synthesis confirms that deduced by Crabbé, *et al.* Although these investigators report the same melting point for the compound IX itself, they obtained its 4,6-dibromo derivative only as an oil.

(6) E. Schwenk and D. Papa, *J. Org. Chem.*, **10**, 232 (1945).

(7) D. Papa, E. Schwenk and H. Ginsberg, *ibid.*, **16**, 251 (1951).

in the presence of Raney nickel catalyst under the usual conditions for reductive cleavage.[8] When an ethanol solution of the derivative was boiled with Raney nickel catalyst, hydrolysis of the tosyl group and reduction occurred, since the substituted ethane XVI was again isolated.

Acknowledgment.—We thank Mr. R. N. Boos and his associates for the microanalyses and Mr. R. Walker for determination and interpretation of the infrared spectra. The potentiometric titration was carried out by Mr. J. Wittick.

Experimental

2-(2,6-Dimethoxy-3,4-methylenedioxyphenyl)-benzofuran (II).—A suspension of 155 mg. of the product from yeast in 20 ml. of 2 *N* sodium hydroxide solution was treated with 3 ml. of dimethyl sulfate which was added in small increments with shaking. After the addition was completed, a white solid formed. This mixture was allowed to stand at room temperature for one hour and was then extracted five times with ether. The ether extract was dried and concentrated, leaving a colorless oil, 137 mg., which crystallized. The methyl derivative, or 2-(2,6-dimethoxy-3,4-methylenedioxyphenyl)-benzofuran (II), melted at 117–118.5° after recrystallization from a mixture of ether and petroleum ether. It apparently exists in isomorphic crystalline forms, since some preparations melted at 105–106° and others at the higher range. A sample prepared using diazomethane, in the manner previously described,[1] melted at 105–106°. A mixture of the two forms melted at 118°. The infrared spectra of the two forms were identical when determined in carbon disulfide solution.

Anal. (sample prepared with diazomethane): Calcd. for $C_{16}H_{14}O_5$: C, 68.45; H, 4.73. Found: C, 68.56; H, 4.86.

2-(6-Acetoxy-2-methoxy-3,4-methylenedioxyphenyl)-benzofuran (III).—A solution of 29 mg. of the product in 3 ml. of pyridine and 1 ml. of acetic anhydride was allowed to stand at room temperature for two days. The solvents were removed *in vacuo* to yield a crystalline residue which, upon recrystallization from cyclohexane, gave 29 mg. of the acetyl derivative III, m.p. 112–113°, λ_{max}^{EtOH} 296 mμ, $E_{1\,cm}^{1\,\%}$ 582.

Anal. Calcd. for $C_{18}H_{14}O_6$: C, 66.25; H, 4.32. Found: C, 66.33; H, 4.35.

Alkaline Fusion.—A mixture of 14 mg. of the product, a pellet of potassium hydroxide and one drop of water was heated in an uncovered gold vessel to 230° over a period of 10 minutes and maintained at that temperature for an additional 5 minutes. The cooled melt was dissolved in water, and the solution was acidified and extracted with ether. The ether extract was divided into neutral, sodium bicarbonate-soluble and sodium hydroxide-soluble fractions. The material derived from the sodium bicarbonate extraction, 3.0 mg. on sublimation yielded colorless crystals, m.p. 145–150°, of slightly impure salicylic acid. The melting point of a mixture of this product with a sample of pure salicylic acid, m.p. 157–158°, was 152–157°. A different sample, similarly prepared but further purified, had an infrared spectrum indistinguishable from that of authentic salicylic acid.

Oxidation with Sodium Chromate.—A solution of 53 mg. of the product and 250 mg. of sodium chromate in 10 ml. of glacial acetic acid was allowed to stand at room temperature for 0.5 hour. The reaction was allowed to continue an additional half-hour at 90° and the mixture was then diluted with water. The green aqueous solution was extracted with ether and the organic layer fractionated into its acidic and neutral components by appropriate extraction with aqueous sodium bicarbonate. The acidic fraction, 12 mg., on sublimation gave 6 mg. of a crystalline acid. After recrystallization of this product from cyclohexane it melted at 196–197°, and was shown to be identical with coumarilic acid (IV) by mixed melting point determination and comparison of infrared absorption spectra.

Anal. Calcd. for $C_7H_6O_3$: C, 66.67; H, 3.73; equiv. wt. (potentiometric titration), 162. Found: C, 67.25; H, 3.81; equiv. wt., 178.

2,6-Dimethoxy-3,4-methylenedioxy-2′-hydroxybenzoin (VI).—A solution of 519 mg. of osmium tetroxide in 1.5 ml. of benzene was added to a mixture of 610 mg. of 2-(2,6-dimethoxy-3,4-methylenedioxyphenyl)-benzofuran (II) and 1.5 ml. of benzene. Eight drops of pyridine was added and the mixture was allowed to stand at room temperature for 5 days. It was then treated with 20 ml. of ethanol and 20 ml. of a saturated aqueous solution of sodium sulfite, stirred for 20 hours at room temperature, and then diluted with 200 ml. of water. After acidification with dilute hydrochloric acid, the aqueous solution was extracted with five 100-ml. portions of ether. The aqueous phase was discarded, and the combined ether extracts washed with a small volume of water and then stirred vigorously with 50 ml. of 1 *N* sodium hydroxide solution. This extraction procedure was repeated four times and the combined alkaline extract was washed once with ether. The aqueous alkaline extract was acidified with dilute hydrochloric acid and again extracted with ether, yielding 298 mg. of the crude crystalline benzoin VI. After several recrystallizations from ether, yellow crystals of 2,6-dimethoxy-3,4-methylenedioxy-2′-hydroxybenzoin were obtained, m.p. 136.5–137°; λ_{max}^{EtOH} 245 mμ, $E_{1\,cm}^{1\,\%}$ 508, λ_{max}^{EtOH} 287 mμ, $E_{1\,cm}^{1\,\%}$ 330, and λ_{max}^{EtOH} 337 mμ, $E_{1\,cm}^{1\,\%}$ 262.

Anal. Calcd. for $C_{17}H_{16}O_7$: C, 61.44; H, 4.85. Found: C, 62.01; H, 4.58.

A 299-mg. quantity of starting material was recovered from the ether extracts which had been extracted five times with alkali. The yield of crude crystalline benzoin, corrected for the recovery of starting material, was 86%.

2,6-Dimethoxy-3,4-methylenedioxyphenylglyoxylic Acid (VII).—A solution of 33 mg. of the substituted benzoin VI in 12 ml. of acetone was treated with a solution of 117 mg. of potassium permanganate in 2 ml. of water. After 18 hours at room temperature, the acetone was removed *in vacuo* and the aqueous solution was treated with sodium bisulfite to remove excess permanganate and manganese dioxide. Solid sodium bicarbonate was added in excess and the aqueous solution was extracted with ether. The bicarbonate solution was then acidified and again extracted with ether. This second ether extract gave 16 mg. of acidic material which, after several recrystallizations from a mixture of ether and low-boiling petroleum ether, yielded yellow crystals of 2,6-dimethoxy-3,4-methylenedioxyphenylglyoxylic acid (VII), m.p. 139–139.5°; λ_{max}^{KBr} 2.9–3.0, 3.2, 5.78, 5.99, 6.1–6.2 μ.

Anal. Calcd. for $C_{11}H_{10}O_7$: C, 51.97; H, 3.97. Found: C, 52.11; H, 3.95.

2,6-Dimethoxy-3,4-methylenedioxybenzoic Acid (VIII).—A 16-mg. quantity of 2,6-dimethoxy-3,4-methylenedioxyphenylglyoxylic acid (VII) was dissolved in 0.6 ml. of 30% acetic acid and treated with a fine suspension of 29 mg. of lead tetraacetate in 1.2 ml. of glacial acetic acid. After standing at room temperature for two hours with stirring, the mixture was diluted with water, acidified with dilute hydrochloric acid and extracted with ether. The 12-mg. quantity of crude 2,6-dimethoxy-3,4-methylenedioxybenzoic acid (VIII) so obtained was recrystallized from ether–petroleum ether and sublimed at reduced pressure to yield the pure acid, m.p. 154–155°. When this acid was mixed with an authentic sample of 2,6-dimethoxy-3,4-methylenedioxybenzoic acid[3] of m.p. 155–156°, the melting point was 154–155°. The identity of the natural and synthetic compounds was verified by their infrared spectra.

1,5-Dimethoxy-2,3-methylenedioxybenzene (IX).—A 2-mg. sample of 2,6-dimethoxy-3,4-methylenedioxyphenylglyoxylic acid (VII) was heated in a tube at 180–190° at atmospheric pressure. The sublimate which collected on the cool portion of the tube crystallized. Recrystallization of the material from petroleum ether with the aid of cooling in a Dry Ice-bath yielded 1,5-dimethoxy-2,3-methylenedioxybenzene (IX), m.p. 42–43°.

This product also was obtained when 2,6-dimethoxy-3,4-methylenedioxybenzoic acid (VIII) was treated in the same manner.

1,5-Dibromo-2,6-dimethoxy-3,4-methylenedioxybenzene (X).—A small sample of 1,5-dimethoxy-2,3-methylenedioxybenzene (IX) was dissolved in one drop of acetic acid and an excess of bromine in acetic acid solution was added. After 0.5 hour at room temperature, the solvent was removed, yielding a crystalline residue. Recrystallization from petroleum ether gave colorless crystals of 1,5-dibromo-2,6-dimethoxy-3,4-methylenedioxybenzene (X), m.p. 95–

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(8) G. W. Kenner and M. A. Murray, *J. Chem. Soc.*, 5178 (1949).

95.5°. Upon admixture with a synthetic preparation of 1,5-dibromo-2,6-dimethoxy-3,4-methylenedioxybenzene,[2] m.p. 94–95°, the melting point was 94–95°. The infrared absorption spectra of the natural specimen was indistinguishable from that of the synthetic one.

2-(6-Ethoxy-2-methoxy-3,4-methylenedioxyphenyl)-benzofuran (XI).—To a stirred mixture of 300 mg. of the product from yeast in 45 ml. of 2 *N* sodium hydroxide solution at 80°, 8 ml. of diethyl sulfate was added portionwise. After a total of three hours, the cooled alkaline mixture was extracted five times with ether. The ether extract was dried and concentrated to a colorless oil which crystallized on standing. The solid was recrystallized from a mixture of ether and petroleum ether, affording 271 mg. of 2-(6-ethoxy-2-methoxy-3,4-methylenedioxyphenyl)-benzofuran (XI), m.p. 111–112°.

Anal. Calcd. for $C_{18}H_{16}O_5$: C, 69.22; H, 5.16. Found: C, 69.43; H, 5.14.

6-Ethoxy-2-methoxy-3,4-methylenedioxy-2′-hydroxybenzoin (XII).—The solution of 259 mg. of 2-(6-ethoxy-2-methoxy-3,4-methylenedioxyphenyl)-benzofuran (XI) in 1 ml. of benzene was added to a solution of 220 mg. of osmium tetroxide in 0.7 ml. of benzene. Three drops of pyridine was added and the mixture was kept at room temperature for 48 hours. Eight milliliters of ethanol and 10 ml. of a saturated solution of sodium sulfite were added and the mixture was stirred at room temperature for 16 hours. A yellow crystalline solid was isolated from the reaction mixture by the same steps described above for the preparation of the corresponding methyl derivative VI. It was recrystallized from a mixture of ether and petroleum ether to yield 114 mg. of 6-ethoxy-2-methoxy-3,4-methylenedioxy-2′-hydroxybenzoin (XII), m.p. 129–130°; λ_{max}^{EtOH} 240 mμ, $E_{1\,cm}^{1\,\%}$ 471; λ_{max}^{EtOH} 287.5, $E_{1\,cm}^{1\,\%}$ 292; and λ_{max}^{EtOH} 334, $E_{1\,cm}^{1\,\%}$ 233.

6-Ethoxy-2-methoxy-3,4-methylenedioxyphenylglyoxylic Acid (XIII).—A mixture of 81 mg. of 6-ethoxy-2-methoxy-3,4-methylenedioxy-2′-hydroxybenzoin (XII) and 290 mg. of potassium permanganate in 5 ml. of water and 30 ml. of acetone was kept at 24° for 42 hours. The solvent was removed under reduced pressure, the residue suspended in 50 ml. of water, the mixture decolorized with sodium bisulfite, and excess sodium bicarbonate was added. The basic mixture was washed with ether, after which the aqueous phase was acidified with hydrochloric acid and extracted with ether. The ether extract from the acidic aqueous phase was dried and concentrated to a brown, partly crystalline residue. The crude product was purified by radial paper chromatography using the upper phase of the system prepared by equilibrating 40 volumes of butanol, 11 volumes of ethanol and 19 volumes of an aqueous buffer which was 1.5 *N* with respect to both ammonia and ammonium carbonate. The zone (observed by ultraviolet fluorescence) of R_f 0.54 was cut out and the paper extracted with dilute aqueous alkali. The alkaline extract was washed with ether, acidified and the acidic solution extracted with ether. Concentration of the ether extract of the acidic solution yielded a residue of 6-ethoxy-2-methoxy-3,4-methylenedioxyphenylglyoxylic acid (XIII).

5-Ethoxy-1-methoxy-2,3-methylenedioxybenzene (XIV).—A small unweighed sample of 6-ethoxy-2-methoxy-3,4-methylenedioxyglyoxylic acid (XIII) was heated in a tube at 210° at atmospheric pressure. An oily distillate of 5-ethoxy-1-methoxy-2,3-methylenedioxybenzene (XIV) collected in the cool portion of the tube.

1,5-Dibromo-6-ethoxy-2-methoxy-3,4-methylenedioxybenzene (XV).—A small quantity of 5-ethoxy-1-methoxy-2,3-methylenedioxybenzene (XIV) was dissolved in acetic acid and treated with an excess of bromine in acetic acid solution. After one-half hour at room temperature, the solvent was removed, yielding a crystalline residue, m.p. 68–70°. Recrystallization from petroleum ether gave 1,5-dibromo-6-ethoxy-2-methoxy-3,4-methylenedioxybenzene (XV), m.p. 71–72°. After admixture with a synthetic specimen of 1,5-dibromo-6-ethoxy-2-methoxy-3,4-methylenedioxybenzene[2] of m.p. 74–75°, the melting point was 72–73°. The identity of the natural and synthetic bromo compounds was verified by their infrared absorption spectra.

1-(2-Hydroxyphenyl)-2-(2-hydroxy-6-methoxy-4,5-methylenedioxyphenyl)-ethane (XVI).—A mixture of 110 mg. of the product from yeast and 0.7 g. of Raney nickel catalyst in 15 ml. of ethanol was refluxed for 3.5 hours. The catalyst was removed, washed with alcohol, and the solvent evaporated *in vacuo*. The residue was dissolved in aqueous alkali and washed with ether. After acidification, the aqueous layer was extracted with ether three times to yield 83 mg. of a crystalline residue. After several recrystallizations from a mixture of ether and petroleum ether, the product, 1-(2-hydroxyphenyl)-2-(2-hydroxy-6-methoxy-4,5-methylenedioxyphenyl)-ethane, melted at 128–129°.

1-(2-Acetoxyphenyl)-2-(2-acetoxy-6-methoxy-4,5-methylenedioxyphenyl)-ethane (XVII).—A solution of 25 ml. of the dihydroxy compound XVI in 1 ml. of pyridine and 0.5 ml. of acetic anhydride was allowed to stand at 5° for 16 hours. The solvent then was removed *in vacuo*, leaving 29 mg. of a crystalline residue. Several recrystallizations of the acetyl derivative from a mixture of ether–petroleum ether gave the pure product, m.p. 87–88°.

Anal. Calcd. for $C_{20}H_{18}O_7$: C, 64.51; H, 5.41; acetyl, 23.1; methoxyl, 8.4. Found: C, 64.09; H, 5.35; acetyl, 23.6; methoxyl, 8.2.

2-(2-Methoxy-3,4-methylenedioxy-6-p-toluenesulfonoxyphenyl)-benzofuran (XVIII).—To a solution of 106 mg. of the product from yeast in 1.3 ml. of pyridine was added 74 mg. of *p*-toluenesulfonyl chloride. The resulting solution was stored at 4° overnight. The mixture was diluted with water, extracted with ether, and the ether extract washed successively with dilute hydrochloric acid, sodium bicarbonate, and water. The ethereal solution was dried, the ether removed, and the resulting white crystalline solid (92 mg.) was recrystallized from ethanol. This afforded white granules of 2-(2-methoxy-3,4-methylenedioxy-6-*p*-toluenesulfonoxyphenyl)-benzofuran, m.p. 118–119.5°.

Anal. Calcd. for $C_{23}H_{18}O_7S$: C, 63.00; H, 4.14. Found: C, 63.43; H, 4.27.

RAHWAY, N. J.