

separate in amorphous form. Tripterine melts at 205° with decomposition.

Recently Gisvold³ isolated from the root bark of bitterweet a red pigment which he named "celastrol." From the description of its properties, it appeared to be identical with tripterine, and from a sample of celastrol kindly furnished by Dr. Gisvold the identity of the two compounds has been confirmed. A mixture melting point of celastrol and tripterine shows no depression. Both are dissolved by dilute alkali or carbonate solution with the formation of a dark red solution which is slowly oxidized by air and readily by permanganate, with the formation of a yellow amorphous acid. Lower fatty acids, such as formic, acetic, or propionic, are absent in the oxidation products. Both compounds are readily reduced by catalytic hydrogen and by sulfurous acid, and the original red color is restored on exposure to air or when the solution is boiled to remove sulfur dioxide. Both give a green color with alcoholic ferric chloride.

Conclusive proof that the compounds are the same is given by the identity of the absorption spectrum of tripterine in ethanol as given in Fig. 1 with that of a sample of celastrol furnished by Gisvold over the range of wave lengths, 400 to 750 millimicrons.⁴

The absorption maximum at 420 millimicrons is of interest because many orthoquinones exhibit a maximum in the range of 400–450 millimicrons.⁵ However, these compounds also possess a maximum at about 333 millimicrons owing to the $-C=C-C=O$ grouping.^{5,6} Its absence in the spectrum of tripterine may be accounted for by the possible presence of a hydroxyl group in the *peri* position, since it has been shown that such groups suppress or modify the maximum due to the conjugated carbonyl grouping.⁶ Such an interpretation would lend support to one of the structures proposed by Gisvold for celastrol,

(3) Gisvold, *J. Am. Pharm. Assoc.*, **28**, 440 (1939); **29**, 432 (1940).

(4) Grateful acknowledgment is made to R. Stewart, of the U. S. Food and Drug Administration, for the absorption spectra of tripterine and celastrol taken from 400–750 millimicrons with a recording spectrophotometer, and to R. E. Davis, of the Bureau of Animal Industry, for the visible and ultraviolet absorption spectrum of tripterine taken from 260–500 millimicrons with a quartz Littrow spectrograph.

(5) Cooke, Macbeth and Winzor, *J. Chem. Soc.*, 878 (1939). The data of these authors indicate that the presence of a maximum in the range 400–450 millimicrons having $\log \epsilon = ca. 3.25-3.30$ in conjunction with a maximum due to the conjugated keto group at about 330 millimicrons is fairly good evidence of a β -naphthoquinone structure.

(6) Macbeth, Price and Winzor, *ibid.*, 330 (1935).

namely, a *peri*-hydroxy-*o*-naphthoquinone derivative.

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE
U. S. DEPARTMENT OF AGRICULTURE

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The Polymorphism of *d*-Galactose Diethylmercaptal Pentaacetate*

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A recent attempt to prepare *d*-galactose diethylmercaptal pentaacetate by the procedure of Wolfrom¹ yielded a product having properties at considerable variance with those recorded for this compound. Although *d*-galactose diethylmercaptal pentaacetate has been used by several investigators in the carbohydrate field, we were unable to find any description of its properties other than those reported by Wolfrom¹ and Wolfrom and Thompson,² who have described the substance as prismatic needles melting between 77 and 79°, and having a specific rotation of +9.7–9.9° in U. S. P. chloroform.

In the course of establishing the identity of our product with an authentic specimen from Dr. Wolfrom's laboratory, it was found that the compound may exist in three forms³ which exhibit different melting point behavior and optical crystallographic properties. By choice of seed crystals, it was possible to obtain from the same solution hexagonal prisms, rectangular plates or elongated prisms. When melting points were determined in the usual manner in capillary tubes, the hexagonal and elongated prism forms underwent volume changes or incipient melting at 76.5–77° and 80.5–81°, respectively, but did not melt completely until the temperature was raised to 90.5–91°. Both forms completely melted in tubes plunged into a bath heated to one or two degrees above their respective shrinkage points, and occasionally slowly solidified and remelted at 90.5–91°. When melting points of these two forms were determined on a Fisher micromelting point apparatus, complete melting occurred at the temperatures at which shrinkages had taken place in capillary tubes, and there was no tendency toward resolidification unless large amounts

* Not copyrighted.

(1) Wolfrom, *THIS JOURNAL*, **52**, 2464 (1930).

(2) Wolfrom and Thompson, *ibid.*, **56**, 880 (1934).

(3) Private communication has revealed that dimorphism of this substance has been recognized independently by Drs. S. B. Hendricks and G. E. Hilbert of the Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture. This note was submitted with their approval.

of material had been placed between the cover glasses. The rectangular plate form melted at 90.5–91°, and underwent no change below this temperature range aside from sintering just prior to actual melting. This was true in both capillary and micromelting point determinations.

The authentic specimen consisted of elongated prisms. Repeated capillary melting point determinations which were carried out on finely powdered material showed that it melted completely at 80.5–81°, and that there was no tendency toward resolidification above this temperature. With the exception of capillary melting point behavior, the specimen was identical in every respect with the elongated prisms which were referred to in the preceding paragraph, and which were obtained by using crystals of the specimen as seed. As indicated in the description of experimental work, the tendency of material prepared in our laboratory to exhibit double melting point characteristics was due to the presence of the rectangular form (m. p. 90.5–91°) in such small concentrations as to be undetectable by ordinary means.

Once the elongated prism form was obtained, the spontaneous deposition of the hexagonal and rectangular forms from supersaturated solutions was no longer observed. Even in the presence of appropriate seed crystals, it was difficult to obtain crops of these forms free from microscopically detectable elongated prisms.

Experimental

All temperatures are corrected. Capillary melting points were determined using soft glass tubes in a mechanically stirred oil-bath, the temperature of which was raised at a rate of about 10° per minute to a point 10° below the anticipated fusion or shrinkage point. The temperature was then raised 0.5° per minute while the specimen was inspected by means of a 3-power lens. In micromelting point determinations, crystal specimens were observed with a ten to 45 power binocular microscope, and the temperature rise was *ca.* 0.5° per minute in the vicinity of the melting point.

Authentic Specimen of *d*-Galactose Diethylmercaptal Pentaacetate.—A communication which accompanied this material stated that it had been "recrystallized four times from hot methanol by the addition of water just short of opalescence and cooled slowly" and then "dried under vacuum over phosphorus pentoxide at the temperature of boiling chloroform for eight hours." The specimen consisted of elongated, clear glassy prisms. When crushed for study by the immersion method, there resulted irregular angular fragments, some of which extinguished sharply with crossed nicols (parallel polarized light) while others remained essentially bright under the same conditions when the microscope stage was revolved. In convergent

polarized light (crossed nicols), partial biaxial interference figures were commonly found, especially those showing one optic axis in the interference figure. Refractive indices were: $n_\alpha = 1.496$, $n_\beta = 1.535$, $n_\gamma = 1.549$; all ± 0.003 . The maximum value was least commonly found. Immersion media consisting of suitable mixtures of methylene iodide, chloronaphthalene and mineral oil were used in these determinations, and rapid work was necessary because of the tendency of the specimen to dissolve. The melting point (capillary and micro) was 80.5–81°. The substance formed a clear, stable melt which slowly solidified and remelted at 90.5–91° only after introduction of a seed crystal of the high-melting form. It gave a specific rotation value⁴ of +7.3°.

Anal. Acetyl: calcd. for $(C_2H_5S)_2C_6H_7O_5(CH_3CO)_5$: 10.1 cc. of 0.1 *N* NaOH per 100 mg. Found: 10.2 cc.

Experiment 1.—Twenty-five grams of *d*-galactose diethylmercaptal (m. p. 141–142°) was dissolved in 88 cc. of *c. p.* pyridine, and acetylated with 127 cc. of acetic anhydride according to the procedure of Wolfrom.¹ The crude product readily solidified after the reaction mixture was poured into ice and water, and amounted to 48.6 g. It was dissolved in 100 cc. of methanol at *ca.* 30°, and water gradually added with stirring. Permanent opalescence and subsequent crystallization occurred after 40 cc. of water had been added, and the mixture was chilled and filtered. The crystals were identified as Crop I and amounted to 37.8 g. of irregularly shaped plates which, when finely powdered, gave a capillary melting point of 90.5–91° after undergoing sudden shrinkage at 76.5–77°. When several crystals were placed between cover glasses on a Fisher micromelting point apparatus, they would melt completely when the temperature was raised to 77°. Use of larger amounts (*ca.* 1–2 mg.) of material in this determination usually resulted in obtaining a melt at 77° which slowly resolidified above this temperature and then remelted at 91°. This may have been due to the setting up of a temperature gradient in the larger quantity of material, or to the possibility that a specimen of such size was more representative of the composition of the entire mass than were a few isolated crystals. The resolidified material was used subsequently as seed in obtaining crops of the rectangular plate form.

Crop II was obtained by adding 40 cc. of water to the filtrate from Crop I and consisted of 2.1 g. of rectangular plates which gave a melting point (capillary and micro) of 90.5–91°, with no changes significantly below this temperature.

Experiment 2.—Thirty grams of Crop I was recrystallized three additional times from methanol–water as in Experiment 1. Seed crystals from the authentic specimen were used to initiate crystallization. The four times recrystallized product consisted of small elongated prisms (Fig. 1) having optical crystallographic properties identical with those of the seed crystals. In a capillary tube, it formed a turbid melt at 80.5–81°: slow solidification then occurred, and on reheating a melting point of 90.5–91° was obtained.

(4) All specific rotations are referred to the D line of sodium, and were determined at a temperature of 22°, using 2-dm. tubes and toluene solutions containing 4.6 g. of substance per 100 cc. of solution. In U. S. P. chloroform, all other conditions being the same, the three polymorphic forms gave values in the range of +10.8–11°.

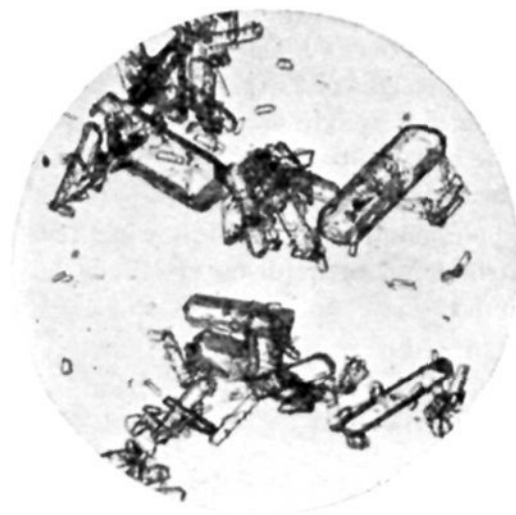


Fig. 1.—70 X.

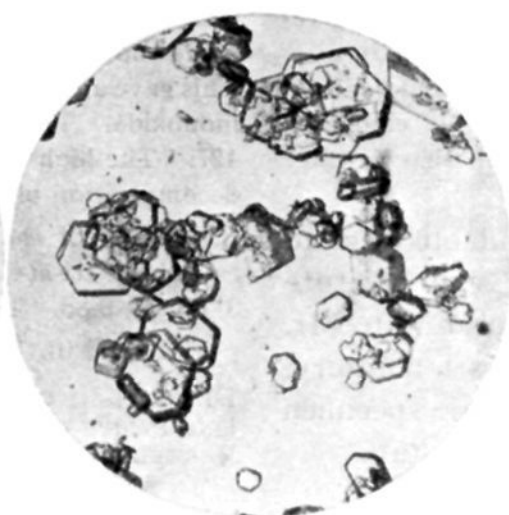


Fig. 2.—70 X.

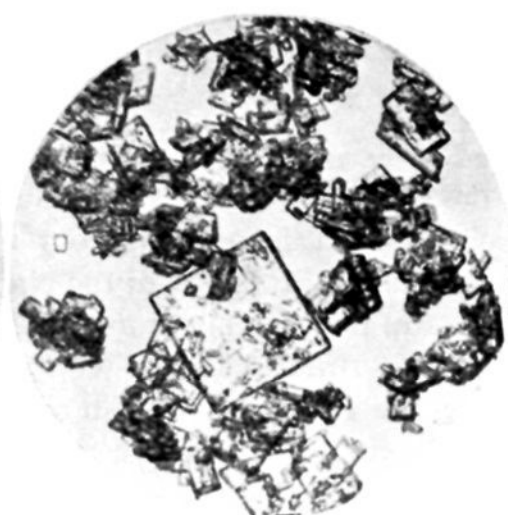


Fig. 3.—70 X.

A clear melt resulted on plunging a capillary tube sample into a bath at 83°. The specific rotation was +7.3°.

Anal. Acetyl. Found: 10.1 cc. of 0.1 *N* NaOH per 100 mg.

Experiment 3.—Twenty grams of four times recrystallized material was dissolved in 60 cc. of methanol to obtain a stock solution for use in securing crops of the different forms. Five cc. of solution was pipetted into a test-tube (15 × 125 mm.), and 2 cc. of water added by means of a pipet. The tube was agitated cautiously while being warmed to 40°, then it was stoppered and allowed to cool slowly and uniformly to 27–28°. By this means, a supersaturated solution was obtained. Introduction of a seed crystal from Crop I caused the deposition of hexagonal prisms. Rectangular plates were precipitated on seeding the solution with material which had resolidified above 81°. The progress of crystallization was followed by means of a 45-power binocular microscope. Spontaneous deposition of elongated prisms was common. When this occurred, the solution was refluxed to eliminate all crystalline matter, the tube stoppered and allowed to cool, and the seeding process repeated. Crops of the rectangular plate form were the most difficult to obtain free from elongated prisms. After numerous crystals of the desired form had been deposited, the tube was shaken to effect rapid deposition of additional material. The crop (approximately 1 g.) was filtered off, dried four hours in vacuum over calcium chloride and examined for crystalline homogeneity.

Hexagonal Prism Form.—These crystals (Fig. 2) were of varying degrees of thickness, and broke up into angular fragments when prepared for examination by the immersion method. When examined with crossed nicols (parallel polarized light), it was characteristic of the substance to show many fragments which did not extinguish when the microscope stage was revolved. These fragments showed partial biaxial interference figures in convergent polarized light (crossed nicols), especially with one optic axis, and occasionally the acute bisectrix, in the microscopical field. The optic sign was negative. Refractive indices were: $n_{\alpha} = 1.480$, $n_{\beta} = 1.518$ (very common), $n_{\gamma} = 1.532$; all ± 0.002 . The melting point was 77° (micro) and 90.5–91° after sudden shrinkage at 76.5–77° (capillary). A capillary specimen plunged into a bath at 79° formed a clear melt. The specific rotation was +7.3°.

Anal. Acetyl. Found: 10.2 cc. of 0.1 *N* NaOH per 100 mg.

Rectangular Plate Form.—These crystals (Fig. 3) occasionally occurred as laminated aggregates. When crushed for study by the immersion method, there resulted irregular angular fragments, some of which extinguished sharply with crossed nicols (parallel polarized light), while many others remained bright, or partially so, when the stage was revolved. In convergent polarized light (crossed nicols), biaxial interference figures were common, showing the acute bisectrix and sections perpendicular to an optic axis. The optic sign was negative, and $2E$ small. When crystal fragments were immersed in chloronaphthalene–methylene iodide mixtures during β and γ refractive index determinations, the formation of elongated six-sided prisms occurred in the media. This process probably represented the spontaneous formation of the more stable elongated prism form (m. p. 80.5–81°). Since it took place slowly, determination of the intermediate and maximum refractive indices was not precluded: $n_{\alpha} = 1.482$ (± 0.002), $n_{\beta} = 1.505$, $n_{\gamma} = 1.517$ (both ± 0.003). The specific rotation was +7.4°, and the melting point (capillary and micro) 90.5–91° with no previous detectable change.

Anal. Acetyl. Found: 10.2 cc. of 0.1 *N* NaOH per 100 mg.

Experiment 4.—One hundred milligrams of the authentic specimen and 0.1 mg. of the rectangular plate form were intimately ground to a powder in an agate mortar. In capillary tubes, specimens of the mixture melted at 90.5–91° and underwent slight, if any, change at 80–81°. Gradual and very slight shrinkage seemed to occur as the bath temperature was raised to this point, and probably resulted from transformation occurring in the solid state. Specimens plunged into a bath at 82° formed turbid melts which slowly resolidified.

Experiment 5.—A supersaturated solution was prepared as in Experiment 3 and seeded with the rectangular form. Rectangular plates gradually deposited on the bottom of the tube. In a few minutes, deposition of elongated prisms was noted, and a few seed crystals of the hexagonal form were introduced. By this procedure was obtained a mixture of the three forms in roughly equal amounts. The system was observed occasionally with the microscope during the course of an hour. The hexagonal and rectangular forms acquired an eroded appearance and gradu-

ally dissolved, while crystals of the elongated form retained their sharp characteristics and increased in size. After twelve hours, only elongated prisms could be detected. The experiment demonstrated the elongated prisms to be the form least soluble in methanol-water mixtures.

We wish to acknowledge our indebtedness to Dr. Raymond M. Hann, of the National Institute of Health, for a supply of *d*-galactose, and to Mr. Robert L. Brown, of Dr. Wolfrom's laboratory, Ohio State University, for an authentic specimen of *d*-galactose diethylmercaptal pentaacetate.

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NEW COMPOUNDS

Preparation of Tri-*m*-nitrophenyl Orthoformate

In an attempt to prepare *p*-nitrosalicylaldehyde, a modified Reimer-Tiemann reaction was used as outlined by D. E. Armstrong and D. H. Richardson [*J. Chem. Soc.*, 496 (1933)]. Instead of the desired compound, tri-*m*-nitrophenyl orthoformate was obtained. Fourteen grams of *m*-nitrophenol was dissolved in a solution of 56 g. of potassium hydroxide in 70 cc. of water. The solution was heated to 90° and trichloroacetic acid was added slowly. After violent boiling ceased, the mixture was diluted to three times its original volume and filtered. The light colored precipitate was washed with methyl alcohol and dried. Two and one-half grams of this substance was obtained. The solution was acidified and extracted with ether, which recovered 7.5 g. of *m*-nitrophenol. The acid solution was filtered after the extraction and 3 g. of tar was obtained.

The original precipitate (2.5 g.) from the alkaline solution, which melted at 182–183°, was recrystallized from butyl alcohol and small brownish colored crystals were obtained which melted at 182–183°.

When this compound was treated with warm sulfuric acid, it dissolved and a gas was evolved which was found to be carbon monoxide. Upon dilution of the sulfuric acid solution and filtering, the resulting precipitate was found to be *m*-nitrophenol.

A weighed sample of the compound was treated with

concentrated sulfuric acid in an atmosphere of carbon dioxide and the gas collected over 40% potassium hydroxide. This gave an equivalent weight of 480 g. per mole of carbon monoxide. The molecular weight of $(\text{NO}_2\text{C}_6\text{H}_4\text{O})_3\text{CH}$ is 427. The high value can be accounted for by incomplete decomposition of the sample.

Analysis of the compound gave the following results: calcd. for tri-*m*-nitrophenyl orthoformate: C, 53.4; H, 3.04; N, 9.85. Found: C, 53.45; H, 2.95; N, 10.44.

The yield in this procedure was 17.5%.

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γ -Phenoxypropyl *p*-Anisyl Ketone

The ether was removed from the Grignard reagent prepared from 62 g. of *p*-bromoanisole in 150 cc. of anhydrous ether, and the residue was cooled in an ice-bath. To this was added slowly, with swirling and cooling, a solution of 39 g. of γ -phenoxybutyronitrile¹ in 150 cc. of dry benzene. A considerable amount of heat was evolved. After the mixture had been refluxed for twelve hours, it was cooled and hydrolyzed with ice-cold ammonium chloride solution. The two layers were separated quickly and the benzene solution was shaken with cold dilute hydrochloric acid (1:5). The oily imine hydrochloride which separated was removed with the water layer, and the acid extraction was repeated twice, as rapidly as possible. The combined acid mixture was then warmed for two hours on a steam-bath and the resulting ketone extracted with benzene and ether. The solution was washed with sodium bisulfite solution and water and distilled. The fraction boiling at 200–210° (0.5 mm.) was collected and recrystallized from methanol; yield, 26 g. of colorless leaflets; m. p. 58–60°. After another recrystallization the compound melted at 59–60.5°. The original benzene layer, after the acid extraction, was distilled, and from the fraction of b. p. 195–210° (0.5 mm.) there was obtained an additional 11.5 g. of slightly less pure ketone; m. p. 56–60° to a cloudy liquid.

Anal. Calcd. for $\text{C}_{17}\text{H}_{19}\text{O}_3$: C, 75.5; H, 6.7. Found: C, 75.4; H, 6.9.

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(1) Marvel and Tannenbaum, *This Journal*, **44**, 2647 (1922).