

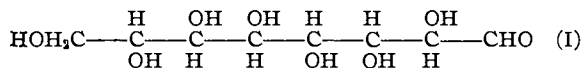
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Aldehydo Derivatives of D- α , α -Galactose (D-Gala-L-gala-octose)¹

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In prior publications from this Laboratory the aldehydo derivatives of D- β -galaheptose² (D-gala-L-gluco-heptose)³ and D- α -galaheptose⁴ (D-gala-L-manno-heptose) have been described. Attention was directed to the fact that, while the magnitude of the molecular rotations of the ring derivatives of D-gala-L-manno-heptose were comparable to those of similar ones of L-mannose,⁵ no such agreement in rotation was evident among the true aldehydo compounds of like structure in the two series.

Recently we have described a number of derivatives of D- α , α -galactose (D-gala-L-gala-octose) (I)



and the observations indicated good agreement between the properties of the compounds of this sugar and similar ones of L-galactose and also between derivatives of D-gala-L-gala-octonic acid and L-galactonic acid. It seemed desirable to prepare a number of the true aldehydo derivatives of the octose in order to compare their properties with those of similar substances from the L-galactose series. The general methods developed by Wolfrom

TABLE I

COMPARISON OF SPECIFIC ROTATIONS $[\alpha]^{20}_D$ OF COMPOUNDS IN THE D-GALACTOSE AND D-GALA-L-GALA-OCTOSE SERIES

Compound	D-Galactose series	D-Gala-L-gala-octose series
Ethyl mercaptal	- 3.5	- 3.2
Ethyl mercaptal penta- or heptaacetate	+ 9.7 ²	+29.9
Aldehydo penta- or heptaacetate	-25 ⁴	+71.3
Aldehydo oxime penta- or heptaacetate	+34 ⁶	+20.2
Aldehydo oxime hexa- or octaacetate	+23.6 ⁷	+14.9
Aldehydo hepta- or nonaacetate	+ 4.0 ⁹	+26.1
Aldehydo semicarbazone penta- or heptaacetate	+89 ^{8,10}	-27.0
Acid nitrile penta- or heptaacetate	+43.2 ⁷	+ 8.5

(1) Publication authorized by the Surgeon General, U. S. Public Health Service.

(2) Hann and Hudson, *THIS JOURNAL*, **56**, 2080 (1934).

(3) Concerning this nomenclature see Hudson, *ibid.*, **60**, 1537 (1938).

(4) Hann and Hudson, *ibid.*, **59**, 1898 (1937).

(5) Hann, Merrill and Hudson, *ibid.*, **57**, 2100 (1935).

(6) Wolfrom, *THIS JOURNAL*, **52**, 2467 (1930).

(7) Deulofeu, Wolfrom, Cattaneo, Christman and Georges, *ibid.*, **55**, 3491 (1933).

(8) Wolfrom, Thompson and Georges, *ibid.*, **54**, 4094 (1932).

(9) Pirie, *Biochem. J.*, **30**, 324 (1936).

(10) Wolfrom, Georges and Soltzberg, *THIS JOURNAL*, **56**, 1797 (1934).

and his co-workers for obtaining aldehydo compounds in the hexose series were employed and found to be readily applicable for the octose. An examination of the specific rotations recorded in Table I indicates a lack of correspondence in rotation of compounds of comparable structure in the two series and it seems evident that aldehydo derivatives of similar sugars do not show the similarity in properties that has been found to hold for ring compounds.

We express our appreciation to Dr. W. T. Haskins for performing the micro-analyses in connection with this work.

Experimental

D-Gala-L-gala-octose Ethyl Mercaptal.—A solution of 10 g. of D-gala-L-gala-octose monohydrate in 20 cc. of concentrated hydrochloric acid was shaken at room temperature with 15 cc. of technical ethyl mercaptan, when slight warming followed by rapid crystallization of the mercaptal took place. After standing for one hour, 100 cc. of ice water was added, the precipitate filtered and washed successively with 25 cc. of 50% ethyl alcohol and 25 cc. of 95% alcohol, and dried; yield 13.3 g. (quantitative). The mercaptal crystallized from 100 parts of hot water in colorless plates melting at 214° (corr.) and showing a specific rotation¹¹ of -3.2° (*c*, 0.72) in absolute pyridine.

Anal. Calcd. for C₁₂H₂₆O₇S₂: C, 41.58; H, 7.57. Found: C, 41.75; H, 7.50.

D-Gala-L-gala-octose Ethyl Mercaptal Heptaacetate.—The solution of 5 g. of the octose mercaptal in a mixture of 25 cc. of pyridine and 25 cc. of acetic anhydride was completed by heating gently, and the reaction mixture, after standing overnight, was poured upon crushed ice. The thick sirup which separated was difficult to bring to crystallization until it had been washed thoroughly by repeated treatments with hot water; yield 9.1 g. (98%). The acetate is readily recrystallized from 10 parts of 50% alcohol, separating in flat truncated prisms which melt at 106° (corr.) and rotate +29.9° in chloroform (*c*, 1.47).

Anal. Calcd. for C₂₈H₄₀O₁₄S₂: C, 48.72; H, 6.30. Found: C, 48.61; H, 6.30.

Aldehydo-D-gala-L-gala-octose Heptaacetate.—To a solution of 10 g. of D-gala-L-gala-octose ethyl mercaptal heptaacetate and 15.3 g. of mercuric chloride (3.6 moles) in 110 cc. of acetone, 10 g. of washed cadmium carbonate was added and the resulting reaction mixture refluxed gently for one-half hour. The separated solid was filtered off and washed with three portions of 25 cc. of acetone. On cooling the filtrate to room temperature 1.4 g. of

(11) All rotations are constant specific rotations at 20° for sodium light and *c* is concentration in grams in 100 cc. of solution.

needles (m. p. 165°) separated. The mother liquors were concentrated *in vacuo* to dryness, the residue extracted with 125 cc. of warm chloroform, and the chloroform extract again concentrated *in vacuo* to a dry residue weighing 5.8 g. (m. p. 158–163°); total crude yield 7.2 g. (87%).

Aldehydo-D-gala-L-gala-octose heptaacetate separates from its solution in 30 parts of boiling acetone in colorless needles, which melt at 164–165° (corr.) and have a specific rotation in absolute chloroform of +71.3° (*c*, 1.32).

Anal. Calcd. for C₂₂H₃₀O₁₅: C, 49.42; H, 5.66. Found: C, 49.34; H, 5.63.

Aldehydo-D-gala-L-gala-octose Oxime Heptaacetate.—A solution of hydroxylamine was prepared by refluxing 4 g. of pulverized hydroxylamine hydrochloride with 8 g. of fused potassium acetate in 15 cc. of absolute alcohol. The separated potassium chloride was filtered off, and the hot solution added to a hot solution of 2.0 g. of aldehydo-D-gala-L-gala-octose heptaacetate in 40 cc. of absolute alcohol. Experience indicated that further heating reduced the yield, so the reaction mixture was allowed to cool slowly to room temperature and placed in the ice-box overnight. A first fraction of 1.5 g. of crystalline material was filtered off, and a further separation of 0.2 g. obtained by concentration of the mother liquors by an air current at room temperature; yield 1.7 g. (81%).

Aldehydo-D-gala-L-gala-octose oxime heptaacetate crystallized from its solution in 10 parts of alcohol in colorless needles, melting at 179–179.5° (corr.) and having a specific rotation of +20.2° in absolute chloroform (*c*, 0.89).

Anal. Calcd. for C₂₂H₃₁O₁₅N: C, 48.06; H, 5.69; N, 2.55. Found: C, 48.06; H, 5.84; N, 2.52.

Aldehydo-D-gala-L-gala-octose Oxime Octaacetate.—A solution of 1.5 g. of aldehydo-D-gala-L-gala-octose oxime heptaacetate in a mixture of 15 cc. of pyridine and 15 cc. of acetic anhydride was allowed to stand overnight at room temperature and then poured upon crushed ice. The precipitated solid (1.0 g., 62%) was recrystallized from 10 cc. of alcohol, separating in needles melting at 187–188° (corr.) and rotating +14.9° in absolute chloroform (*c*, 0.81).

Anal. Calcd. for C₂₄H₃₃O₁₆N: C, 48.71; H, 5.62. Found: C, 48.72; H, 5.54.

D-Gala-L-gala-octonic Nitrile Heptaacetate.—(1) A suspension of 1 g. of D-gala-L-gala-octose oxime octaacetate and 1 g. of fused sodium acetate in 5 cc. of acetic anhydride was refluxed for five minutes and then poured into crushed ice, the tacky mass which separated was washed several times with water and a crystalline brown powder finally obtained in a yield of 0.6 g. (67%). (2) One gram of the oxime octaacetate was heated to 190° in an oil-bath when acetic acid was evolved and sublimation of shining needles to the cooler surfaces of the reaction vessel was noted. Following heating for one-half hour the melt was cooled and it crystallized to a mass of needles; yield 0.85 g. (94%). The acetylated nitrile was recrystallized

from 10 parts of alcohol, separating in needles melting at 185° (corr.) and rotating +8.5° in absolute chloroform (*c*, 0.92). The sign of rotation does not agree with that expected for an acetylated nitrile having an acetoxy group on the left of carbon two.¹²

Anal. Calcd. for C₂₂H₂₉O₁₄N: C, 49.70; H, 5.50. Found: C, 49.59; H, 5.57.

Aldehydo-D-gala-L-gala-octose Semicarbazone Heptaacetate.—A solution of 1 g. of aldehydo-D-gala-L-gala-octose heptaacetate, 0.3 g. of semicarbazide hydrochloride and 0.4 g. of fused potassium acetate in 10 cc. of absolute alcohol was refluxed for five minutes, the alcohol was driven off by an air current and 20 cc. of water added to the residue; crystallization of 0.6 g. (54%) of the desired product readily occurred. The semicarbazone heptaacetate separates from 20 parts of hot alcohol in small plates which melt at 203–204° (corr.) and rotate –27.0° in absolute chloroform (*c*, 0.96).

Anal. Calcd. for C₂₃H₃₅O₁₅N₃: C, 46.68; H, 5.62. Found: C, 46.63; H, 5.76.

Aldehydo-D-gala-L-gala-octose Nonaacetate.—A solution of 2.0 g. of aldehydo-D-gala-L-gala-octose heptaacetate in 15 cc. of a mixture of two parts of acetic anhydride and one part of acetic acid containing 2% of concentrated sulfuric acid by volume was allowed to stand overnight at 20°, then poured upon crushed ice; the sirup which separated slowly crystallized; yield 2.0 (83%). The nonaacetate, upon recrystallizing from 10 parts of 50% alcohol, separates in nodular groups of small needles. The compound melts at 149–150° (corr.) and rotates +26.1° in absolute chloroform (*c*, 1.09).

Anal. Calcd. for C₂₆H₃₆O₁₈: C, 49.03; H, 5.70. Found: C, 49.16; H, 5.74.

The Specific Rotation of D-Galactose Di-ethyl Mercaptal.—No accurate rotation seems to have been recorded for galactose ethyl mercaptal. The compound was prepared by Wolfrom's¹³ modification of Fischer's method and recrystallized from ten parts of boiling water to constant physical properties. It melted at 142–143° (corr.) and rotated –3.5° in pyridine (*c*, 1.33), +6.0° in absolute alcohol (*c*, 1.39) and –4.8° in water (*c*, 1.09).

Summary

A series of open-chain derivatives of D- α , α -galactose (D-gala-L-gala-octose) has been prepared and described. These compounds, upon comparison with similar open-chain derivatives of L-galactose fail to show the parallelism of rotations that was noted in ring compounds in these two series.

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(12) Deulofeu, *Nature*, **131**, 548 (1933).

(13) Wolfrom, *THIS JOURNAL*, **52**, 2466 (1930).