LYOTROPIC PHASE BEHAVIOUR OF 1,2-DIALKY1-3-B-D-XYLOPYRANOSYL-SN GLYCEROL/ FATTY ACID MIXTURES IN EXCESS WATER

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SUMMARY

The lyotropic phase behaviour of 1,2-dialkyl1-3O-B-D-xylopyranosyl-sn-glycerol/fatty acid mixtures in excess water have been studied using X-ray diffraction. It has been observed that like the fully hydrated PC/FA and 1,2,3-B-GaI DAG/FA mixtures, the phase behaviour of fully hydrated 1,2,3-B-D-XyloDAG/FA 1:2 is also quite different both from the phase behaviour of fully hydrated pure 1,2,3-B-XyloDAG, and of pure fatty acid. The fully hydrated 1,2B-XyloDAG with chainlengths C_{12} - C_{14} exhibit lamellar (L_{α}) and H_{II} phases, and those with chainlengths C_{16} - C_{19} exhibit lamellar (L_{α}), H_{II} and inverse micellar Fd3m phases.\(^1\) Whereas the fully hydrated 1,2,3-B-DXyloDAG/FA 1:2 mixtures with C_{16} - C_{18} tend to form mainly lamellar L_{α} and inverse micellar Fd3m cubic phases. The mixture with a chainlength of C_{19} was found to adopt the lamellar (L_{α}) phase and a novel, presumably inverse micellar cubic phase, which has not yet been indexed.\(^1\)

INTRODUCTION

The lyotropic phase behaviour of synthetic double chain glycolipids has been studied extensively. A wide range of glycolipids spontaneously form lamellar (one or more of L_{α}, L_{β} and L_{γ}) bicontinuous cubic (space group Pn3m and Im3m) and inverse hexagonal H_{II} phases.\(^2\) The nonbilayer phases may well be involved in specific cell functions, such as membrane fusion\(^3\) cell recognition\(^4\) interaction with toxins and viruses\(^5\) photosynthesis.\(^6\) But little attention has been paid to the effect of an amphiphile solute on their lyotropic phase behaviour.

Xylopyranosyl-diglycerides are constituents of micro organism. We have considered the lyotropic phase behaviour of XyloDAG/FA 1:2 mixtures in order to study the effect of an amphiphile solute (fatty acid) on the lyotropic phase behaviour of xylopyranosyl-diglycerides.

MATERIAL AND METHODS

The 1,2-di-O-alkyl-1,3-(D-xylopyransyl)-sn-glycerols under consideration were synthesized in University of Albert Edmontom by D.A. Manook according to previously published procedures. Their purity was checked by thin layer chromatography using a solvent system of chloroform/methanol (4/1 (v/v)) and no significant chemical degradation was observed. The water used to prepare the samples was HPLC grade. X-ray diffraction samples were prepared by transferring 5-10 mg of dry lipids lyophilized from cyclohexane into thin walled glass capillaries (diameter 1.5 mm) and adding sufficient water to ensure that the water concentration was greater than 75 wt\%. The
Moreover the X-ray diffraction study also shows that the chain melting transition temperature of the fully hydrated 1,2-β-D-XyloDAG/FA 1:2 mixtures depends roughly linearly on the chainlength, both during heating and cooling scans (see figure-III). Like the fully hydrated 1,2-B-D-XyloDAG/FA 1:2 mixture,11 and fully hydrated PC/FA mixture,12 all fully hydrated 1,2-B-D-XyloDAG/FA 1:2 mixture with the exception of the C_{18} mixture, exhibit an inverse micellar cubic phase Fd3m. For which 9-10 Brag peaks which have reciprocal spacing ratios of √3, √8, √11, √12, √16, √19, √24, √27, √32, √43..., characteristic of a cubic phase of space group Fd3m (=Q^{27}) have been observed in the x-ray diffraction pattern. As is obvious from figure-IV, the lattice parameter of Fd3m cubic phase depends on temperature and the direction (heating or cooling) of the scan, although the slopes are almost equal during heating and cooling. However, at a given temperature for the C_{18} mixture the lattice parameter of the cubic phase is smaller during the heating scan relative to the cooling scan, whereas for the C_{18} mixture it is larger during the heating scan relative to the cooling scan. Figure-IV also clearly shows that the lattice parameter of these mixture also depends on the chain length both during the heating and the cooling scans.

Like the fully hydrated PC/FA12 and 1,2-β-DGalDAG/FA mixture,11 the phase behaviour of fully hydrated 1,2-β-D-XyloDAG/FA 1:2 mixture is also quite different both from the phase behaviour of fully hydrated pure 1,2-β-D-XyloDAG, and of pure fatty acid mentioned elsewhere.11
Moreover the X-ray diffraction study also shows that the chain melting transition temperature of the fully hydrated 1,2-β-D-XyloDAG/FA 1:2 mixtures depends roughly linearly on the chainlength, both during heating and cooling scans (see figure-III). Like the fully hydrated 1,2-B-D-XyloDAG/FA 1:2 mixture, and fully hydrated PC/FA mixture, all fully hydrated 1,2-B-D-XyloDAG/FA 1:2 mixture with the exception of the C_{19} mixture, exhibit an inverse micellar cubic phase Fd3m. For which 9-10 Brag peaks which have reciprocal spacing ratios of \sqrt{3}, \sqrt{8}, \sqrt{11}, \sqrt{12}, \sqrt{16}, \sqrt{19}, \sqrt{24}, \sqrt{27}, \sqrt{32}, \sqrt{43},... characteristic of a cubic phase of space group Fd3m (\equiv Q^{27}) have been observed in the x-ray diffraction pattern. As is obvious from figure- IV, the lattice parameter of Fd3m cubic phase depends on temperature and the direction (heating or cooling) of the scan, although the slopes are almost equal during heating and cooling. However, at a given temperature for the C_{17} mixture the lattice parameter of the cubic phase is smaller during the heating scan relative to the cooling scan, whereas for the C_{18} mixture it is larger during the heating scan relative to the cooling scan. Figure-Iv also clearly shows that the lattice parameter of these mixture also depends on the chain length both during the heating and the cooling scans.

Like the fully hydrated PC/FA and 1,2-β-DGalDAG/FA mixture, the phase behaviour of fully hydrated 1,2-β-D-XyloDAG/FA 1:2 mixture is also quite different both from the phase behaviour of fully hydrated pure 1,2-β-D-XyloDAG, and of pure fatty acid mentioned elsewhere.
fully hydrated 1,2-B-D-XyloDAGs with hydrocarbon chainlengths C_{12} to C_{14} exhibit lamellar (L_{α}) and H_{II} phase, and those with a hydrocarbon chainlength of C_{16} to C_{19} exhibit lamellar (L_{α}), H_{II} inverse micellar Fd3m cubic phases over a temperature range of 30-100 °C. where as fatty acids exhibit a lamellar (L_{α}) phase which transforms into a fluid, inverse micellar solution (L_{α}) phase, both in excess water and in the anhydrous state. On the other hand fully hydrated 1,2-β-D-xylanDAG/FA 1:2 mixtures with chainlengths C_{13}, C_{17} and C_{18} tend to form a lamellar (L_{α}) phase which transforms directly to an inverse micellar Fd3m cubic phase without the formation of the H_{II} phase (the compound with a chainlength of C_{19} forms a lamellar (L_{α}) phase which transforms to a new, presumably inverse micellar cubic phase, also without the formation of an H_{II} phase).

1. All 1:2 fully hydrated mixture of 1,2-β-D-XyloDAG with fatty acids exhibit a lamellar (L_{α}) phase both during the heating and the cooling scans. The stability and lattice parameter of this phase strongly depends on the chainlength, both increasing with increasing chainlength. However, this is presumably simply a consequence of the increase in the chain melting transition with chainlength.

2. The lamellar non lamellar phase transition temperature appears to depend on the hydrocarbon chainlength, increasing wit increasing chainlength.

3. Over the temperature range of 30-100 °C, the fully hydrated 1,2-β-D-XyloDAG/FA 1:2 mixtures with chainlengths C_{13} to C_{18} exhibit the lamellar (L_{α}) and Fd3m cubic phases, although the mixture with a chainlength of C_{19} exhibit a new phase, probably another inverse micellar cubic, whose X-ray pattern still needs to be indexed.

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REFERENCES


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