

Self-Assembly Structures of Branched Chain β -D-Glycosides by Small-Angle X-Ray Scattering

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Previously, several branched chain glycosides were prepared and their liquid crystal behaviours elucidated using simple optical polarising microscope (OPM) and differential scanning calorimeter (DSC). [1] The chemical structures of these synthetic glycosides closely mimic natural glycolipids, differing only in the glycosidic linkage and the sugar type [2]; hence, their self-assembly behaviour is expected to be comparable with that of natural glycolipids, and potentially will be a good substitute for surfactant function in diverse applications [3]. Interestingly, the result from the gluco- and maltosides series [1], gave a logical relationship between the structures and the phases observed [4]. However, this simple rule failed to be applied in the other sugar-lipid series, which suggests there are many more subtle factors that govern the structure and stability of these phases. One of these may be the anomeric purity of the material since many previous studies have shown for example the phase behaviour of α - monoalkylated glycosides is different from that of β -anomer [5].

Here we report on the structural investigation of these branched chain β -D-glycosides, which were synthesized to high purity (>98%) [6], using two reducing sugars (glucose and maltose) and five branched chain Guerbet alcohols whose total hydrocarbon chain length ranges from 8-24. The phases formed, both in the dry state and in excess water, were studied by using small angle x-ray scattering. Both OPM and DSC were used for initial phase identification, transition temperature determination and measurement of the transitional thermodynamic properties. The main aim here was to establish the effects of sugar and branched chain length on the phase structure, both in the dry state, and under excess water conditions. Presently we found, for example, the shortest chain glucoside exhibits a smectic A phase, while the longer chain members adopt a columnar phase, in accordance with previously observed data [1]. However, the measured clearing temperatures differ significantly from those determined previously. In addition, some glucosides adopt an isotropic inverse micellar (L_2) phase over the temperatures range studied, although this was not observed previously. The discrepancy between the previous and present results is mainly due to the higher quality (β -anomer) of the latter samples. The small angle x-ray scattering study gave structural parameters, as well as the symmetry of the phases formed. Apart from these structural properties, the water contents of the lyotropic phases and the surface area per head group, for these were determined. These results are compared with available data from straight chain glycosides and other known branched-chain lipids, in order to reveal the subtle structure-property relationships of these glycosides.

References

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