

Attempted Synthesis of a Glucofuranose Derived Carbohydrate Liquid Crystal

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Introduction

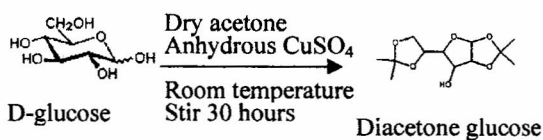
Liquid crystal state is a distinct state of matter observed between the crystalline solids and isotropic liquids. Carbohydrates are an innovative and promising source for the synthesis of liquid crystals as they have easy accessibility and availability, less toxicity, degradability, chirality, low melting temperatures, good solubility in water and organic solvents and clearly defined thermotropic and lyotropic mesophase behavior (Vill, 1998). Mono-, di- or oligosaccharides substituted with one or more alkyl chains containing more than six carbon atoms can create structures with very promising liquid crystal properties. The sugar moieties can be cyclic or acyclic but should have several free hydroxyl groups. The alkyl chain can be linked to the carbohydrate moiety directly or via an ether, thio ether, ester, amino, amide or glyceryl linkage (Smits, 1969). Selective acylation of sugar derivatives is of increasing importance in the field of carbohydrate liquid crystal chemistry. Herein, the synthesis of 3-O-decanoyl-1,2 : 5,6-di-O-isopropylidene- α -D-glucofuranose by the selective acylation of diacetone glucose with a non-traditional acylating agent decanoyl chloride as well as the synthesis of 3-O-decanoyl- α -D-glucofuranose and the investigation of liquid crystal properties of each is presented.

Materials and methods

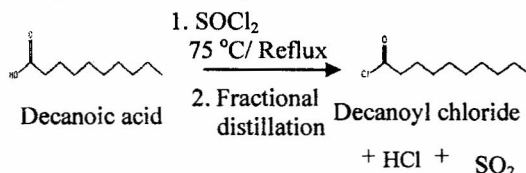
Glucose was purchased from Seelze-Hannover Ltd. and decanoic acid was purchased from Searle Company. All solvents were of Analar grade. Identification of optical texture was carried out using a polarizing microscope. Phase transitions were observed using the temperature controlling device.

The following reaction scheme was utilized for the synthesis of 3-O-decanoyl- α -D-glucofuranose.

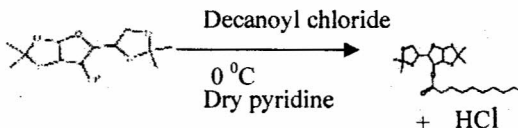
1) Synthesis of diacetone glucose



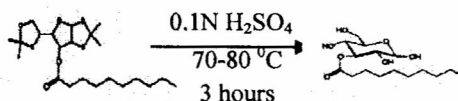
2) Synthesis of decanoyl chloride



3) Synthesis of 3-O-decanoyl-1,2 : 5,6-di-O-isopropylidene- α -D-glucofuranose



4) Synthesis of 3-O-decanoyl- α -D-glucofuranose



Results and discussion

The compound 3-O-decanoyl-1,2 : 5,6-di-O-isopropylidene- α -D-glucofuranose is a furanose sugar with a long non-polar side chain connected to the rigid polar core via an ester linkage, which is the requirement to form a lyotropic liquid crystal. It shows microphase separation (Figure 1(a)). With chloroform, which is non-polar, inverted micelles may be formed. Increasing concentration of the compound may assemble the inverted micelles one on top of the other in columns, which are packed parallel on a two-dimensional lattice having a hexagonal symmetry (Figure 2). Thus,

the phase comprises of orientational order as well as some positional order.

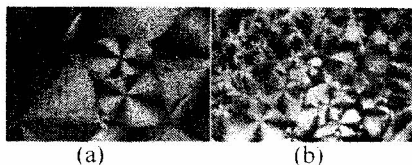


Figure 1. Texture of 3-O-decanoyl-1,2 : 5,6-di-O-isopropylidene- α -D-glucofuranose in the (a) lyotropic hexagonal columnar mesophase (b) thermotropic hexagonal columnar mesophase at room temperature under crossed polarizer and analyzer.

Thermotropic liquid crystal properties were observed by heating a small amount of the sample in a temperature controlling device. The solid melts immediately to an isotropic liquid on heating (117-124 °C), yielding a colorful texture which might correspond to a hexagonal columnar phase, on cooling (55.7 °C) (Figure 1(b)). The texture remained unchanged even at room temperature. Thus, although the compound appears to be solid at room temperature, it may be super cooled and the transition from anisotropic liquid crystalline phase to crystalline solid phase may occur below ambient temperature.



Figure 2. Schematic diagram of a cross section of the two-dimensional array of hexagonal columnar

mesophase with inverted micelles (Daoud, 1998)

The deprotection of 3-O-decanoyl-1,2 : 5,6-di-O-isopropylidene- α -D-glucofuranose yields 3-O-decanoyl- α -D-glucopyranose. Here, no liquid crystal phases were observed.

Conclusions

The carbohydrate liquid crystal 3-O-decanoyl-1,2 : 5,6-di-O-isopropylidene- α -D-glucofuranose was shown to form a lyotropic hexagonal columnar phase with chloroform, as well as a thermotropic hexagonal columnar phase. According to the polarizing microscope studies, the product may be an amphotropic liquid crystal.

Acknowledgements

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References

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