ABSTRACT.

Liquid crystals are fluids that are between the solid and conventional liquid phases. Liquid crystals are in widespread use, especially in optical technologies. They are synthesized by combining fatty acids with cholesterol.

This study aims to utilize coconut oil as an alternative source of fatty acids for synthesizing liquid crystals since coconut is cheap and abundant in the Philippines. Coconut oil is eighty-five percent fatty acids.

This study used commercial coconut oil. Sulfuric acid was used to liberate the fatty acids. When the fatty acid layer was collected, it was mixed with the catalysts DCC (C₇H₁₂N₂N, N,N-dicyclohexylcarbodiimide) and DMAP (C₇H₁₀N₂, 4-dimenopyrimidine) in 1:1 ratio. This was then mixed with commercial cholesterol and stirred until precipitates formed. The precipitates were filtered and the filtrate was collected. The organic layer was separated from the filtrate. The liquid crystal component was determined and isolated through column chromatography and thin-layer chromatography.

Infrared (IR) spectrography confirmed the presence of cholesterol ester. Two melting points, 80°C and 110°C, further showed that the product had liquid crystalline properties.

The success of this project will provide a cheaper alternative to costly commercial liquid crystal and yet another use for coconut oil.

INTRODUCTION

Liquid crystals are one of the foundations of a growing electronic...
world. They have been used in medicine, chemistry, thermometry, entertainment, and even cancer research. It is unfortunate, then, that only few in our country have concentrated on this newly developed field.

This study stems from several previous researches on liquid crystals done the Philippine Science High School. Here, fatty acids from coconut oil were combined with cholesterol to form liquid crystal.

Coconut oil was chosen as an alternative because it is cheap and abundant in the Philippines. It is preferable over the commercially available fatty acids which are very expensive. Coconut oil is eighty-five percent fatty acids.

Should the research be successful, an alternative source of liquid crystals and another use for the ever versatile coconut shall have been discovered.

REVIEW OF RELATED LITERATURE

One usually thinks of a crystal as something hard and solid; a liquid, the opposite. Thus, the name “liquid crystal” seem to contradict. Most substances are either solid or liquid depending on the temperature (Makow, 1989).

Liquid crystals flow like liquids, but exhibit some of the optical properties of crystals.

Since liquid crystalline properties depend upon the stability of particular molecular arrangements, factors affecting molecular interaction are fundamentally important. Liquid crystal behavior is therefore highly sensitive to change in molecular structure which may, for example, alter the thermal stability of the liquid crystal, alter the type of liquid crystal formed or result in the formation of two liquid crystal types (Encyclopedia of Chemistry, 1972). In all its applications, liquid crystals at room temperature are needed. Few compounds meet this requirement, and low melting mixtures giving nematic or cholesteric states are generally used.

Liquid crystals are widely used. Their misotropic properties have been used for flaw detection in industries, for emission control in nuclear research, and even for pathological diagnosis in medicine. Thin films of cholesteric-liquid crystals can give color maps of the temperature of surfaces, and this application (surface thermography) is significant in medicine (in skin thermography and its applications in tumor detection, studies of cardiovascular diseases, etc.), in electronics (for temperature mapping of circuits) and in non-destructive testing of laminates (Encyclopedia of Chemistry, 1972). More widely known is their use in calculators and timepieces. Due to its wide range of applications, liquid crystal technology is the subject of much enthusiastic research. Through these inquiries, science will further magnify the importance of liquid crystal use in modern life.

MATERIALS AND METHODS

I. Extraction of Coconut Fatty Acids

Two hundred sixty grams of potassium hydroxide (KOH) was dissolved in 250 mL of distilled water. One liter of coconut oil and ten mL of ninety-five percent ethanol (C\textsubscript{2}H\textsubscript{5}OH) were then added. The mixture was continuously stirred for about 15 minutes until the reaction was completed. The mixture was then cooled, and ten percent excess sulfuric acid (323.63g) was added to it to liberate the fatty acids. After allowing the mixture to stand for several hours, the liberated fatty acids (lauric acid) were isolated, filtered then collected.

II. Preparation of the Fatty Acids

The fatty acids were combined with the catalysts DCC (C\textsubscript{13}H\textsubscript{22}N\textsubscript{2}, N,N-diocyclohexylcarbo-diamide) and DMAP (C\textsubscript{7}H\textsubscript{10}N\textsubscript{2}, 4-dimethyl-aminopyridine) with a ratio of 0.05:0.05:0.05. 0.516 grams of DCC and 0.0306g DMAP were added for every 1g fatty acids. Dichloromethane was added until the mixture was completely dissolved.

III. Preparation of Cholesterol

1.064 grams (0.05 mole) of cholesterol was placed in a 300 mL flask. This was dissolved in a 300mL flask with dichloromethane and stirred.

IV. Synthesis of Liquid Crystals

The fatty acid-catalyst mixture was combined with the cholesterol in a round bottom flask. A magnetic stirrer
was placed inside. The flask was covered with a tube combining CaCl₂. The mixture was mixed by the magnetic stirrer for 24 hours, or until the precipitates formed.

The precipitates were filtered. The filtrate was collected and acidified by washing three times with 5% HCL and then water. For each washing the bottom layer (organic layer) was extracted. The extracts were combined, then evaporated in the rotary evaporator (rotavapor). The remaining product and the reactants cholesterol; fatty acids, and DCC, were spotted in the thin layer chromatography test using the solvent composed of CH₂Cl₂, hexane, and ethyl acetate (2 ml:1 ml: 10 drops).

The product was dissolved in the aforementioned solvent and passed into a column containing silica gel. Thirty samples were collected consisting of 20 drops per flask. Each sample was spotted in TLC. The sample having spots of the possible product were combined and rotavaped. The remaining product was collected.

RESULTS AND DISCUSSION

The product formed at the bottom later and the reactants, fatty acids appeared like white paste on the top layer. Cholesterol, fatty acids, the product, and DCC were spotted in the thin layer chromatography plates and showed that the product was different from the reactants.

The TLC spots of 18 samples obtained from column chromatography showed that they were possibly the cholesterol ester product. These samples were combined. A white product was collected when the solvent was evaporated in the rotary that the fatty acids an cholesterol had reacted because the peaks at the cholesterol had reached because the peaks at the 1350-1500 wave number were different from the peaks of fatty acids and cholesterol. The product was cholesterol ester; the cholesterol, an alcohol, was esterified by the fatty acids.

The two melting points, 80°C and 110°C, of the product showed that it was in the mesophase, an important liquid crystalline property.

This confirmed that the product is a liquid crystal.

SUMMARY AND CONCLUSION

The fatty acids were extracted from coconut oil. The extract was mixed with DCC and DMAP and reacted with cholesterol to product cholesteryl ester. Subsequent tests showed that cholesteryl ester was produced and that the product had liquid crystalline properties.

It was ascertained from the results that liquids crystal compounds were successfully produced from the reaction of coconut oil fatty acids with cholesterol. Therefore, coconut oil is, a commercially viable alternative to traditional sources of fatty acids for liquids crystal synthesis.

RECOMMENDATIONS

Because the reactions involved are high sensitive, it is recommended that future studies use alternative solvents in the process in particular for the fatty-acids extracts and the DCC-reactant mixture. Furthermore, stricter processes for chemical purification, especially for the dehydration of extracts must be employed to obtain results with lower margins of error.

SELECTED REFERENCES


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