Characterization of Biodiesels and Vegetable Oils and their Corresponding Combustion Residues

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Introduction

Biodiesel is one of the most common alternative fuels and is becoming more predominant on the market today. Due to the emergence of biodiesel forensic analysts should be more aware of biodiesel components and properties since it may be encountered more in arson crime scene samples. Biodiesels are vegetable oil or animal oil based diesel fuels. Vegetable oils themselves undergo burning, self-heating, and spontaneous ignition which means they too, albeit less often, are observed in fire debris samples. Vegetable oils and fuels derived from them are not effectively analyzed using regular fire debris analysis methods. A solvent extraction is more suitable than the typical passive headspace extraction that is used for ignitable liquids. The vegetable oils must also be derivatized in order to convert the fatty acids (FAs) found in the oils to the volatile fatty acid methyl esters (FAMEs) which are necessary for GC-MS analysis. This work will demonstrate and analyze the changes, if any, in the FAME components that are observed between neat and burned alternative fuel accelerants. Biodiesel blends and multiple household oils, such as soy and canola oils, will be used as the accelerants. The findings of this research will aid in further understanding and in recognition of biodiesels and vegetable oils in fire debris.

Question

Are there variations in the FAME components of biodiesels and vegetable oils and their corresponding combustion residues?

Objective

- Characterize neat alternative fuels and their corresponding combustion residues
- Observe any changes that may occur to the FAME components after burning
- Add to the alternative fuel accelerant databases

Background

- Alternative fuels are becoming more popular in the automotive fuel industry and are beginning to enter fire debris casework.
- Previous studies have concluded that there is very little published research regarding the analysis of biodiesels and vegetable oils in forensic evidence (2, 5)
- Forensic analysts should have more knowledge regarding the composition and characteristics of both neat liquids and debris samples of these fuels in order to recognize the key components and perform statistical evaluations

Variables / Research

Controlled variables	Independent variable	Dependent variable
• Procedure for burning • Substrates which the alternative fuels will be burned on; table cloth, curtain, and blanket • Method of analyzing the components	• B5 biodiesel • B20 biodiesel • B100 biodiesel • Soya Oil • Sunflower Oil • Canola Oil	• Change in components of the independent variables after they have been burned in an arson-like setting • Measure components before and after burning by GC-MS

Procedure

Step 1

Analyze the neat liquids by GC-MS in order to compare components with the fire debris.

Step 2

The fuels are burned on different household items. Solvent extraction is most efficient. (1,3,4)

Step 3

Vegetable oils must be derivatized in order to be analyzed by GC-MS (both neat and debris). (1,2)

Step 4

Analyze the fire debris extracts by GC-MS and compare to results of respective neat liquids.

Results

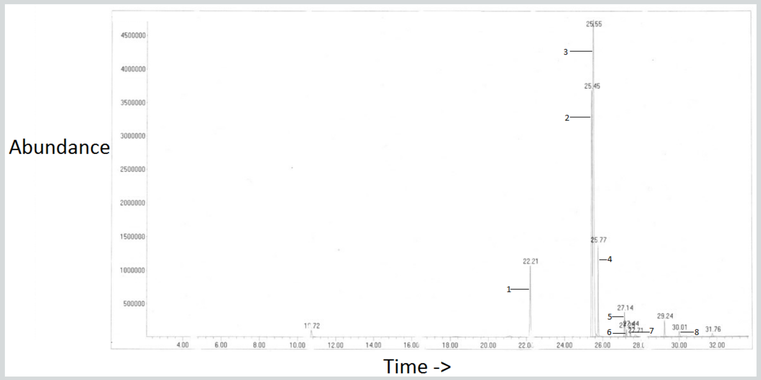

Figure 1: Total Ion Chromatogram of Soya Oil

GC-MS analysis has demonstrated several FAMEs found in soya oil

1. Pentadecanoic acid, 14-methyl, methyl ester
2. 8, 11-Octadecadienoic acid, methyl ester
3. 9-Octadecenoic acid, methyl ester
4. Octadecanoic acid, methyl ester
5. Docosanoic acid, methyl ester
6. 11-Eicosenoic acid, methyl ester
7. Eicosanoic acid, methyl ester
8. Tetracosanoic acid, methyl ester

Conclusion

- Based on preliminary results it is concluded that there are FAMEs found in neat soya oil
- Further research will show if there is a change in the FAME components of biodiesel and vegetable oils after they have been burned

Acknowledgements and References

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