Pyrolysis-Catalytic Hydrogenation of Vegetable Oil

Application Note
Energy

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Vegetable oils generally contain triglycerides of C16 and C18 fatty acids. The fatty acids are relatively volatile, so when they are freed by pyrolysis they mostly appear intact, with some fragmentation, as shown in Figure 1. A pulse pyrolysis of vegetable oil performed in hydrogen looks much the same, since the pyrolysis is more rapid than the hydrogenation.

To pyrolyze a sample and completely hydrogenate the pyrolysis products requires a two-step approach involving a catalyst and reactor. In the first step, the original sample is pyrolyzed, generating volatiles that are carried in hydrogen to the reactor. The second step takes place in the reactor which contains a reducing catalyst and is independently temperature controlled. A sorbent trap is used between the pyrolysis-hydrogenation zone of the instrument and the GC to reduce pressure and switch from the reactant gas (hydrogen) to GC carrier (helium). This permits experiments using the reactor pressure as high as 500 PSI, collecting the products onto the trap and then thermally desorbing them to the GC.

Figure 2 shows a sample of the same vegetable oil, again heated to 700°C for pyrolysis. The pyrolysis products are then carried to a 300°C reactor containing a platinum catalyst, operated at 30 PSI. Here the pyrolysate is thoroughly hydrogenated producing only saturated hydrocarbons.

Figure 1 shows that the main products from just pyrolysis are palmitic and oleic acids, plus many unsaturated hydrocarbons. When the experiment includes the hydrogenation reactor, however, the product distribution is very different. Figure 2 shows that the main products now are a distribution of normal hydrocarbons, containing 11 to 18 carbons, with octadecane being the largest single peak.

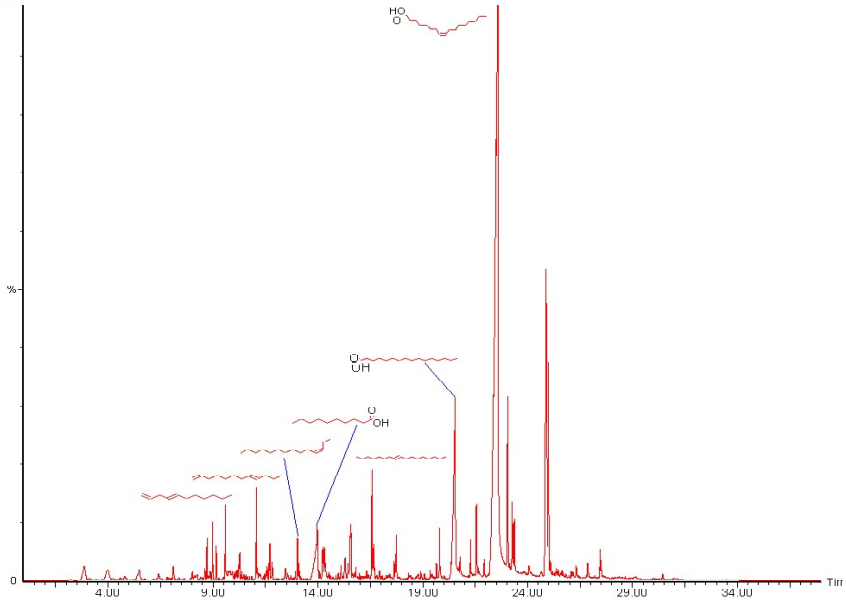

Figure 1. Py-GC/MS of vegetable oil in helium.

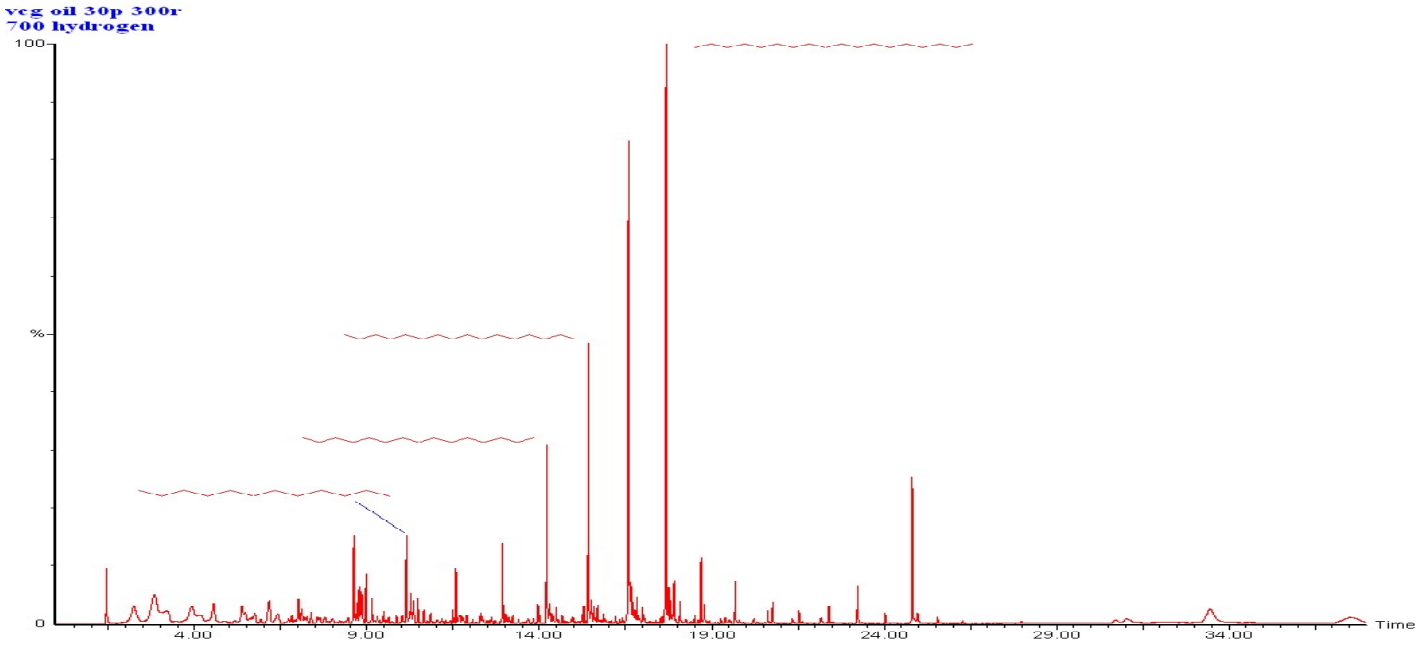

Figure 2. Py-hydrogenation of vegetable oil.

Instrument Conditions

Pyroprobe HPR

Pyrolysis:	750°C 15 seconds
Interface:	300°C 4 minutes
Trap Desorb:	300°C 4 minutes
Hydrogenation	
Reactor Temp:	300°C
Catalyst:	Platinum
Carrier:	Hydrogen
Pressure:	30 PSI
Valve Oven:	300°C
Transfer Line:	325°C

GC/MS

Column:	5% phenyl (30m x 0.25mm)
Carrier:	Helium, 50:1 split
Injector:	350°C
Oven:	40°C for 2 minutes
	10°C/min to 300°C
Mass Range:	35-550

FOR MORE INFORMATION CONCERNING THIS APPLICATION,
WE RECOMMEND THE FOLLOWING READING:

S. Tsuge et al., Structural characterizationof polyolefins by pyrolysis-hydrogenation glass capillary gas chromatography, J. Anal. Appl. Pyrolysis, 1, 1980, 221 - 229.