Rapid Methods to Detect Vegetable Oils Adulteration

Research and Development

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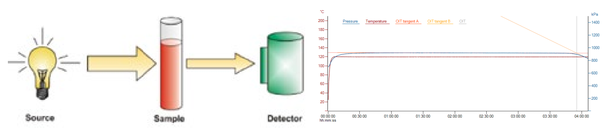
Background

Vegetable oils are essential ingredients in the food industry, and because of availability and/or value, they can be adulterated with a consequent decrease in the nutritional value of the finished product, and quality/safety issues. Several chromatographic techniques coupled with mass spectrometry, nuclear magnetic resonance, and high-resolution thin-layer chromatography have been used to monitor the authenticity of oils and fats, but they are time-consuming and expensive.

In this study, Fourier Transform-Near Infrared (FT-NIR) spectroscopy and RapidOxy were evaluated to monitor oil authenticity. FT-NIR measures the transmission absorption of NIR light in oil samples. While RapidOxy measures the oxygen consumption rate of oil samples in a rapid oxidation condition. They are both benchtop rapid instruments and no sample preparation is required.

Bruker FT -NIR MPA Transmission

RapidOxy 100 (Anton Paar)



Material and Method

1. Material

Refined authentic rapeseed oils (16), sunflower oils (17), and palm oils (22) were collected from different suppliers. The mixture of authentic oils was prepared and adulterated at 3 concentration levels with corn, cotton, safflower, sesame, soybean, mineral, palm kernel, sunflower oil, and wax (Figure 1).

2. Methods

FT-NIR. A Bruker MPA (Bruker Optics GmbH, Ettlingen, Germany) was used. The oil was preheated at 50°C for 15 minutes. Instrument parameters: wavelength 800-2500 nm or 4000-12500 cm^{-1}, 64 scan cycles. Data treatment was performed by the software OPUS.

RapidOxy 100 (Anton Paar Switzerland AG, Aargau, Switzerland) was used. Instrument parameters: sample amount 2 g, T=120°C, and oxygen pressure 7 bar.

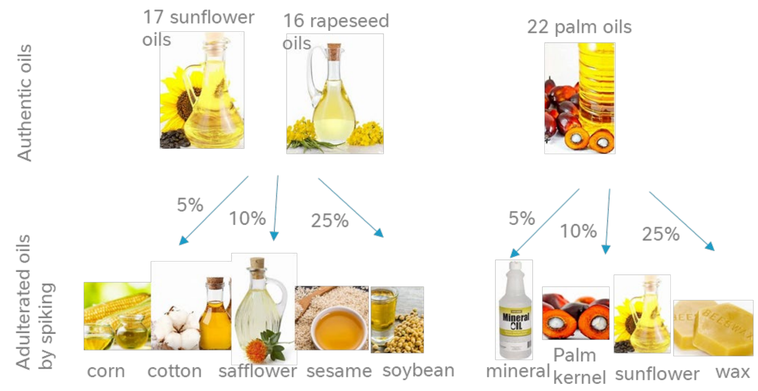


Fig. 1: Illustration of the sample preparation for adulterated oils.

	sunflower	Rapeseed	Safflower	Sesame	Soybean	Corn	Cotton	Palm	Palm olein	Palm kernel
C16:0	5.0-7.6	1.5-6	5.3-8	7.9-12	8-13.5	8.6-16.5	21.4-26.4	39.3-47.5	38-43.5	6.5-10
C18:0	2.7-6.5	0.5-3.1	1.9-2.9	4.8-6.1	2-5.4	ND-3.3	2.1-3.3	3.5-6	3.5-5	1-3
C18:1	14-39.4	8-60	8.4-21.3	35.9-42.3	17-30	20-42.2	14.7-21.7	36-44	39.8-46	12-19
C18:2	48.3-74	11-23	67.8-83.2	41.5-47.9	48-59	34-65.6	46.7-58.2	9-12	10-13.5	1-3.5
C18:3	<0.3	5-13	ND-0.1	0.3-0.4	4.5-11	ND-2	ND-0.4	ND-0.5	ND-0.6	ND-0.2

Fig. 2: Selected fatty acids composition in vegetable oils[1].

Results and Discussion

- FT-NIR could detect rapeseed, sunflower, and palm oil adulteration at different levels.
- Rapeseed and palm oil adulteration could be detected at 5% (Figure 3).
- Sunflower adulteration could be detected at 10% in the presence of cotton oil, 25% in the presence of sesame and soybean oils, and ⩾25% when corn and safflower oils were used as adulterants (Figure 3).
- PCA analysis showed a similarity between sunflower, corn, and safflower oils (Figure 4), probably due to comparable fatty acid composition (Figure 2).
- RapidOxy was also evaluated for oil adulteration detection. However, except for sesame oil, no adulteration below 25% could be detected (Figure 5).

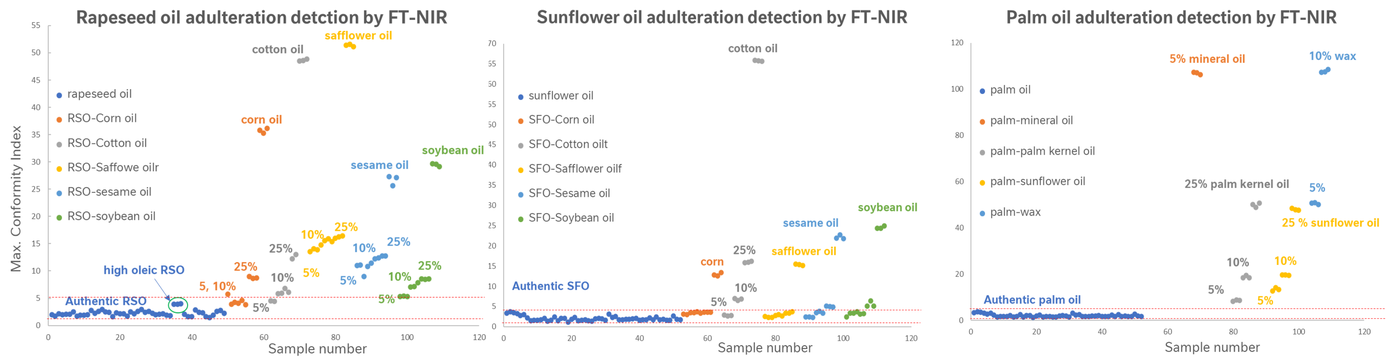


Fig. 3: Conformity tests of rapeseed, sunflower, and palm oils to detect adulteration

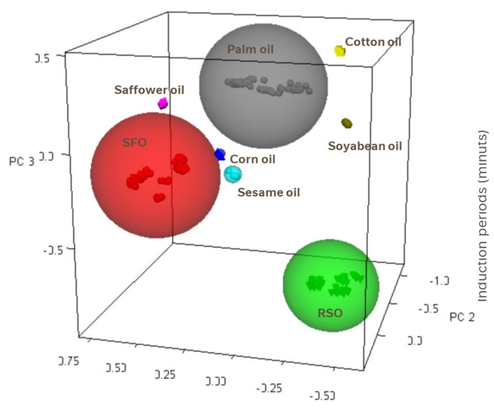


Fig. 4: 3-D PCA of different vegetable oils

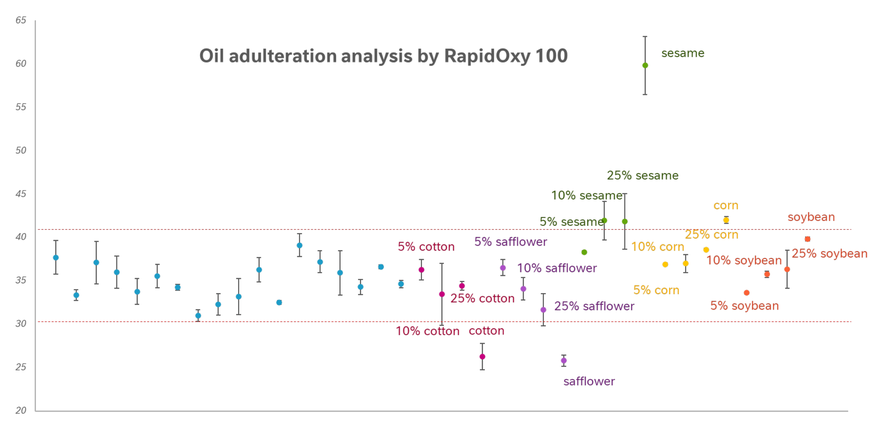


Fig. 5: RapidOxy feasibility study of rapeseed adulteration.

Conclusion

FT-NIR is a sensitive and rapid method for oil adulteration detection. As the next steps, this technique will be validated on rapeseed, sunflower, and palm oil adulteration detection following the fingerprinting validation procedure.

Acknowledgment

Thanks to Charlotte Macron for her dedication to our project management.

Reference:

[1]: Codex standard for named vegetable oils (CODEX -STAN 210-1999)