Colorimetric Determination of Cooking Oil Quality Using a Smartphone

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Cooking Oil Degradation

- **Cooking oil degrades as we use it**

Table 1. Physico-chemical changes during thermal oxidation of various cooking oils.

Vegetable oil	Temperature (°C)	Duration of heating	Physico-chemical changes	References
Canola oil	185 & 215	7 h/day	1. Decrease total polar compounds and anisidine value. 2. Increase vitamin E degradation	Aladedunye and Przybylski 2009
Coconut, safflower, canola & olive oil	180, 210, 240, 270	6 h	Formation of acrolein increased with temperature.	Katragadda et al. 2010
Olive oil	180	1.5–25 h	1. Decrease the quantity of hydroxytyrosol& tyrosol like substances. 2. Degradation of vitamin E and glyceridic fractions. 3. Losses in polyphenols.	Brenes et al. 2002
	180	30–180 min	Decrease concentration of hydroxytyrosol, elenolic acid, decarboxymethyl-oleuropein aglycon, and oleuropein aglycon	Carrasco-Pancorbo et al. 2007
Olive, corn, soybean oils	180	30, 60, 90 min	Increase peroxide value, *p*-anisidine value, FFA	Naz et al. 2005
Palm oil and soybean oil	180	Heated once & 5 times (10 mins)	Decrease vitamin E content and various isomers of vitamin E	Adam et al. 2007
Palm oil	30–320	0–20 min	Increase MDA content, decrease carotenoid content	Oboh, Falade, and Ademiluyi 2014
Peanut oil	220	20 min	1. Increase acid, peroxide value, MDA content. 2. Decrease of total carotenoid content	Falade and Oboh 2015
Sunflower oil	100	52 h	Decrease amount of linoleic acid	Sadoudi, Ammouche, and Ali 2014
Sunflower, grapeseed, soybean, corn & olive oil	180	50 h	Increase quantity of conjugated trienes and total polar components.	Marinova et al. 2012

Ganesan, K., Sukalingam, K., & Xu, B. (2019). Impact of consumption of repeatedly heated cooking oils on the incidence of various cancers- A critical review. *Critical Reviews in Food Science and Nutrition*, *59*(3), 488–505. https://doi.org/10.1080/10408398.2017.1379470

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Cooking Oil Degradation

- Cooking oil degrades as we use it
- **Consumption of degraded cooking oil can cause cancer**

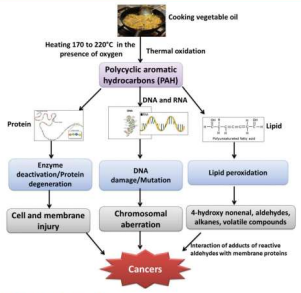

Figure 2. Repeatedly heated cooking oil emits PAHs and subsequent causes of cancer.

Ganesan, K., Sukalingam, K., & Xu, B. (2019). Impact of consumption of repeatedly heated cooking oils on the incidence of various cancers- A critical review. *Critical Reviews in Food Science and Nutrition*, *59*(3), 488–505. https://doi.org/10.1080/10408398.2017.1379470

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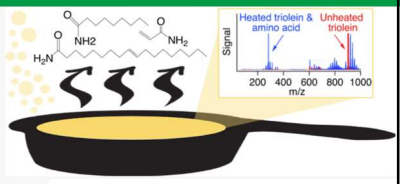
Cooking Oil Degradation

- Cooking oil degrades as we use it
- Consumption of degraded cooking oil can cause cancer
- **Cooking oil degradation decreases air quality**



Ditto, J. C., Abbatt, J. P. D., & Chan, A. W. H. (2022). Gas- and Particle-Phase Amide Emissions from Cooking: Mechanisms and Air Quality Impacts. *Environmental Science and Technology*, *56*(12), 7741–7750. https://doi.org/10.1021/acs.est.2c01409

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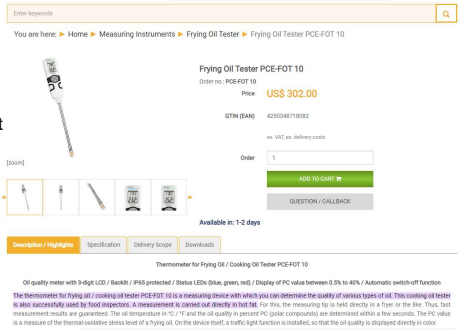
Measuring Cooking Oil Quality

- **Testers are available but are not inexpensive**
  - This one test for polar compounds in cooking oils



https://www.pce-instruments.com/us/measuring-instruments/test-meters/frying-oil-tester-pce-instruments-frying-oil-tester-pce-fot-10-det_5989295.htm#:~:text=The%20thermometer%20for%20frying%20oil,out%20directly%20in%20hot%20fat.

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Colorimetric Changes are Associated with Cooking Oil Degradation

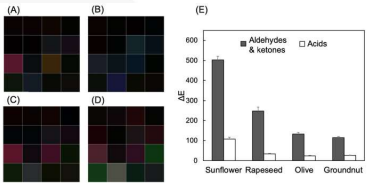

Figure 4. Difference maps showing the change in color (ΔRGB) for each sensor on the array after exposure to (A) rapeseed oil, (B) olive oil, (C) groundnut oil, and (D) sunflower oil; (E) quantification of total volatile aldehydes, ketones, and acids in cooking emissions using CSAs (the y axis shows the sum of ΔE values for sensors 1–6 (white marker) and sensors 7–16 (gray marker); error bars represent standard deviation of triplicates).

Duffy, E., Cauven, E., & Morrin, A. (2021). Colorimetric Sensing of Volatile Organic Compounds Produced from Heated Cooking Oils. *ACS Omega*, *6*(11), 7394–7401. https://doi.org/10.1021/acsomega.0c05667

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Smartphone Camera Cooking Oil Quality Image Analysis

- Others recently used a smartphone camera to measure colorimetric differences between different types of vegetable oil

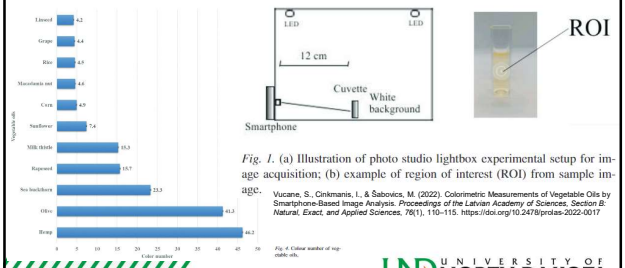

Fig. 1. (a) Illustration of photo studio lightbox experimental setup for image acquisition; (b) example of region of interest (ROI) from sample image.

Vucane, S., Cinkmanis, I., & Šabovics, M. (2022). Colorimetric Measurements of Vegetable Oils by Smartphone-Based Image Analysis. *Proceedings of the Latvian Academy of Sciences, Section B: Natural, Exact, and Applied Sciences, 76*(1), 110–115. https://doi.org/10.2478/prolas-2022-0017

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Smartphone Camera Cooking Oil Quality Image Analysis

- Others recently used a smartphone camera to measure colorimetric differences between different types of vegetable oil
- No one has yet to try to determine cooking oil quality (i.e., level of degradation) using smartphone camera images alone
- Measure markers of oil degradation (i.e., aldehydes and ketones) and compare to smartphone captured images
  - Mass Spectrometry
- Goal is to create an inexpensive tool to measure cooking oil degradation that can be used by everyday people

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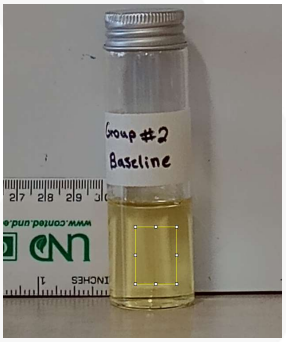
Methods

- 2 Liters of canola oil
- 1 pound (454 g) Orelda ® French fries
- 375º F for 8 minutes with 5 total fries
- Samples collected at baseline, after fry 1, 2, 3, 4, and 5
- Images analyzed using ImageJ
  - Intensity = Sum (number of pixels X intensity)
  - Only Pixels with intensity > 100
  - Unadjusted for background



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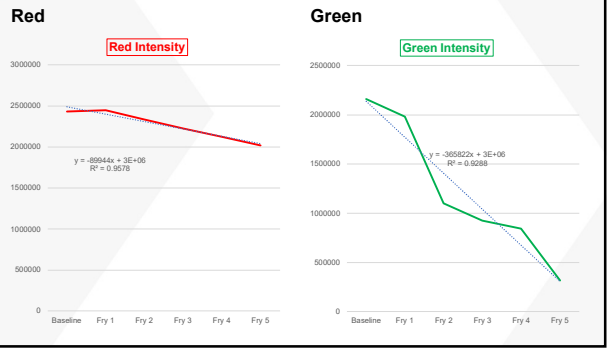
Results



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Future Steps

- Standardize for image background
- Submit oil for mass spectrometry analysis
- Develop robust prediction equation
- Test prediction equation

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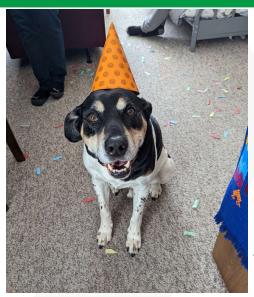
Thanks For Your Time!



How may I answer your questions?

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This is Murphy the happiest boy in the world!

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