Evaluation of wheat germ oil for deep-frying application: chemical stability and sensory evaluation

Anselmo A.[1], Bonciolini A.[1], Napoletano G.[2], Greco Miani M.[2], Cardenia V.[1,*]

[1] Department of Agricultural, Forest and Food Science, University of Turin (Italy);
[2] Casillo Next Gen Food srl, Corato (Italy)

*vladimiro.cardenia@unito.it

INTRODUCTION

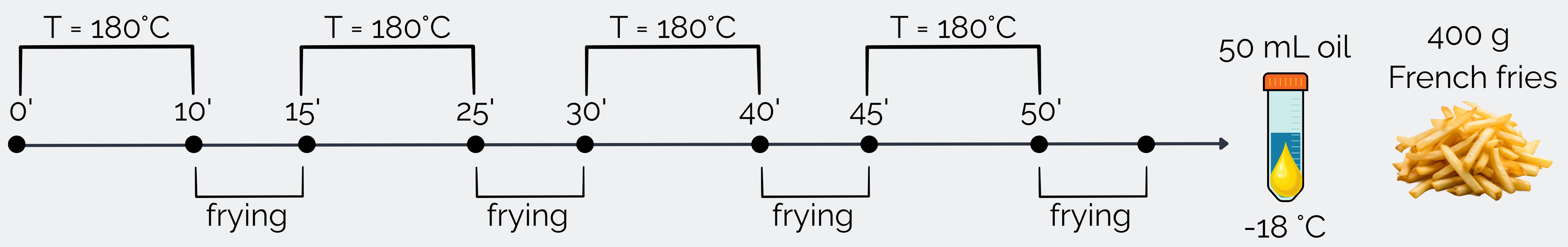
The increasing worldwide demand for edible oils necessitates the assessment of novel sources[1]. **Wheat germ oil**, a by-product of the milling industry, is attracting attention for its **elevated antioxidant content**, rendering it a compelling nutritional alternative to traditional oils[2].

Deep frying is a prevalent culinary technique employed in both domestic and business environments. Although the performance of widely utilized oils, such as sunflower oil, has been thoroughly investigated under prolonged thermal stress conditions (e.g., in the food business), the chemical, physical, and sensory changes of unconventional oils during cooking processes remain largely unstudied[3]. Nonetheless, it is known that substantial alterations in oil characteristics transpire even during brief frying cycles typical of **household usage**[4].

This study aimed to assess the frying performance of wheat germ oil in comparison to conventional oils, specifically **mixed seed oil** and **sunflower oil**. The experiment consisted of 20 cycles of intermittent frying of French fries, conducted over a period of **five days**.

MATERIALS and METHODS

Experimental design[3] of the daily deep-frying



fresh oil refill

Oils analysis

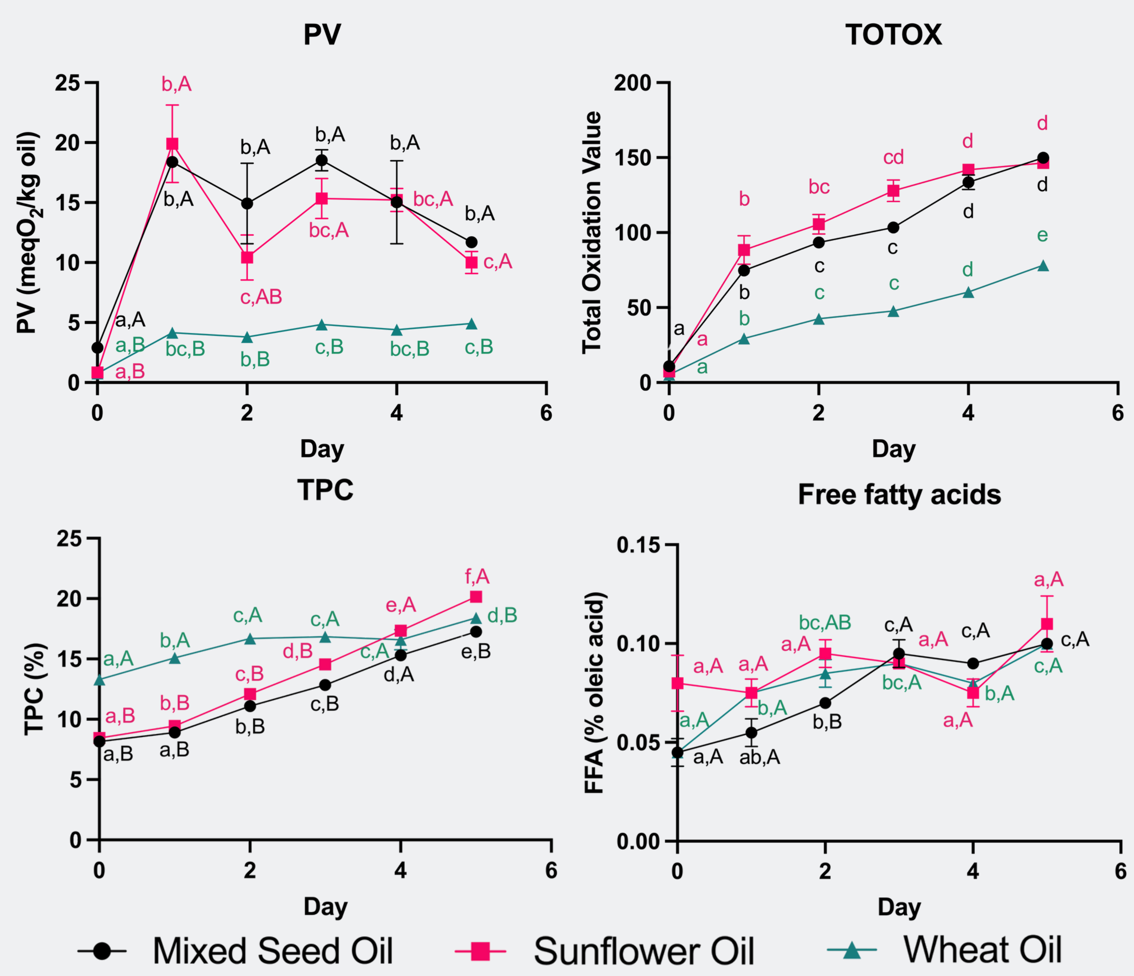
Peroxide value (PV)[5]
***p*-anisidine value** (*p*-AV)[6]
Free fatty acid (FFA)
Total polar compounds (TPC)
Testo 270BT
Volatile Organic Compounds (GC-MS)
Total Fatty Acids Composition (GC-FID)

Sensory analysis

The participants (88 people) were asked to answer a blind satisfaction survey indicating their preferences about **warm French fries** among samples and over days, using a hedonic scale from 1 (extremely unpleasant) to 9 (extremely pleasant).

RESULTS and DISCUSSION

Chemical and physical analysis

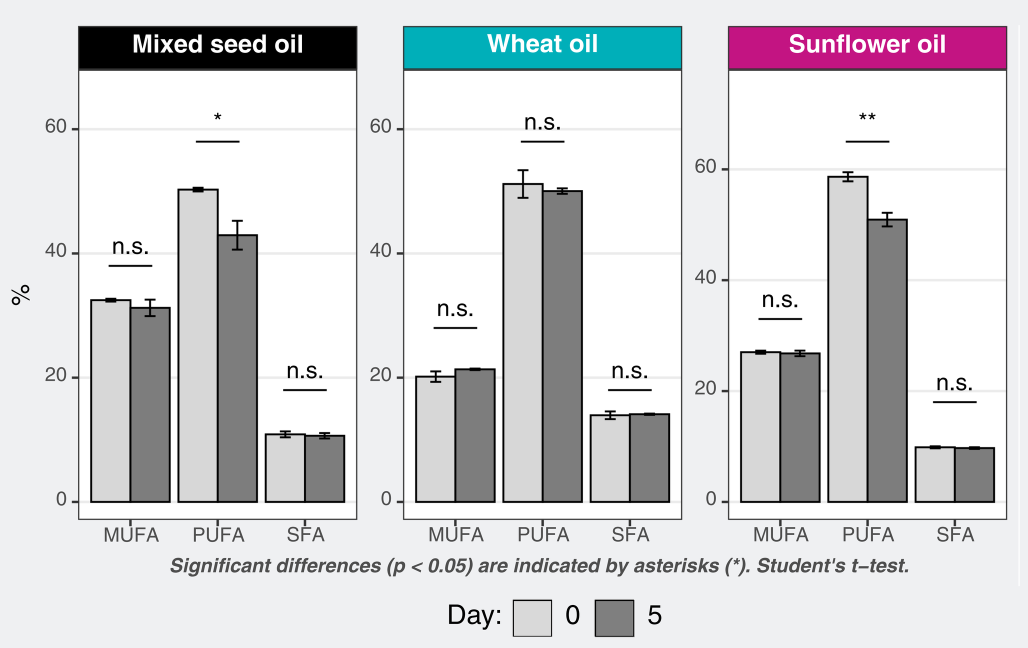


All oils degraded during the frying process, as demonstrated by the increase in **degradation indices** (PV, FFA and TPC).

Wheat oil exhibited greater thermo-oxidative stability for primary (PV) and secondary (*p*-AV, data not shown) oxidation products. The total difference can be seen in **TOTOX** (2 · PV+ *p*-AV).

Different **lowercase letters (a-f)** denote statistically significant differences ($p < 0.05$) for the same oil sample throughout time. Distinct **capital letters (A, C)** denote statistically significant variations ($p < 0.05$) among the various oil samples at the same time point.

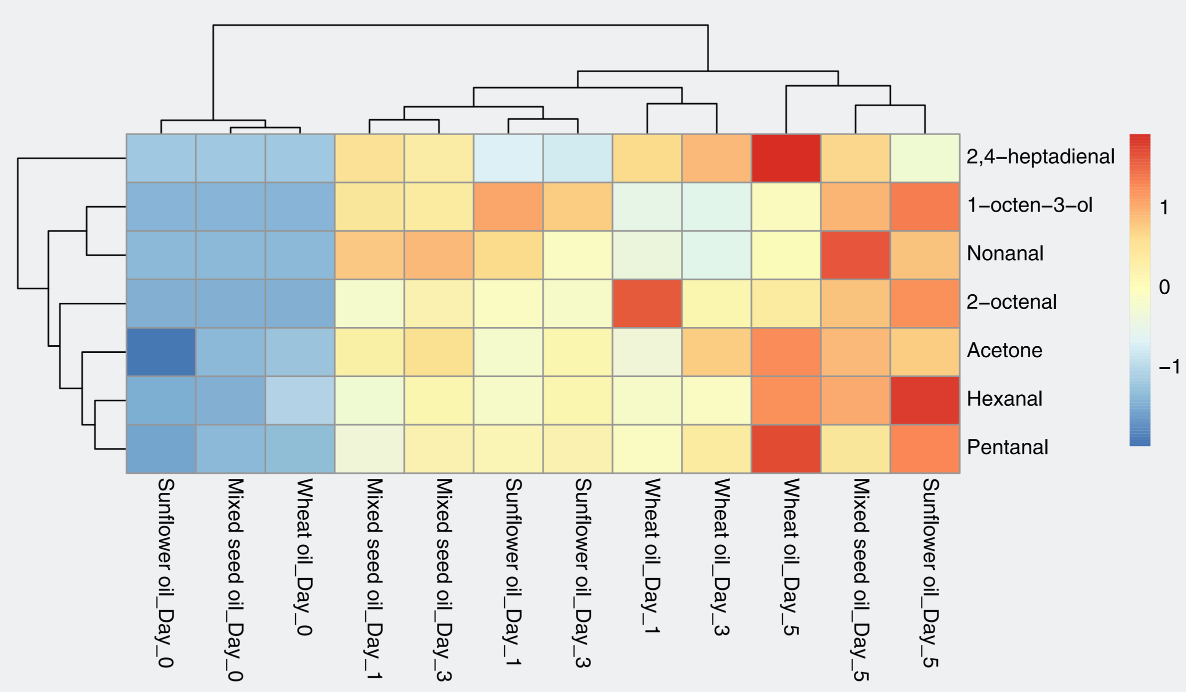
Fatty acid composition



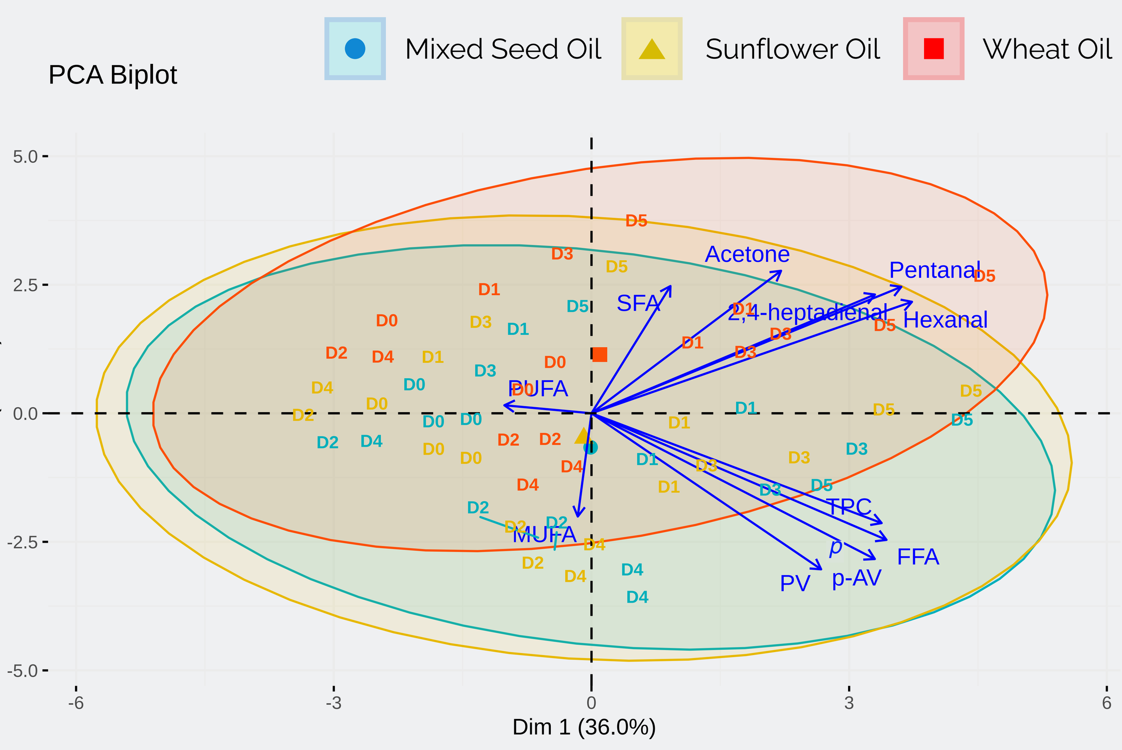
Wheat oil showed minimal fluctuation in **PUFA concentration** following 5 days of frying, indicating higher thermo-oxidative resistance.

The analysis also emphasizes the higher **saturated fatty acid content** of wheat oil (**14%** vs. **9%** for sunflower oil and **10%** for mixed seed oil).

Volatile Organic Compounds analysis



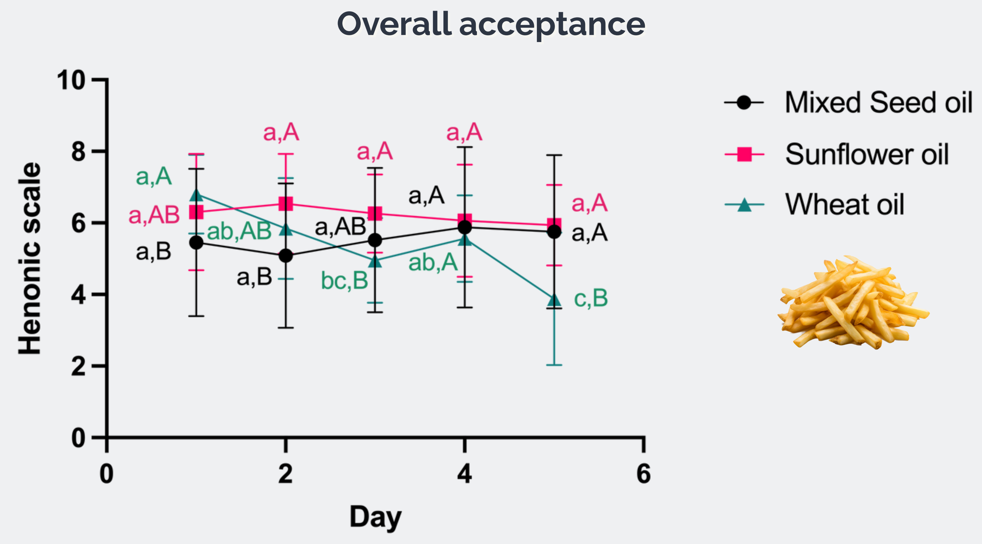
Heatmap cluster analysis identifies **two main groups**: fresh oils (left) and fried oils (right). **Hexanal**, **pentanal**, **acetone**, and **2,4-heptadienal** act as major markers of the oxidation process. The grouping of samples on day 5 suggests that **wheat oil**, being characterized by **acetone** and **2,4-heptadienal**, developed a unique profile of volatile compounds.



The PCA biplot shows that the **frying process** significantly affected oil changes, with fresh oils (left) having higher PUFA levels and degraded oils (right) having higher PV, *p*-AV, TPC, FFA, and volatile compounds like pentanal as well as hexanal. The analysis also confirms the peculiar volatile profile of **wheat oil**.

Sensory analysis

Overall acceptance



Different **lowercase letters (a-f)** indicate statistically significant differences ($p < 0.05$) for French fries fried in the same oil over time. Different **capital letters (A,C)** indicate statistically significant differences ($p < 0.05$) among French fries fried in different oils at the same time point.

CONCLUSIONS

Wheat germ oil exhibits enhanced oxidative stability, likely attributable to its elevated levels of **natural antioxidants** and increased **saturated fatty acid content**.

Notwithstanding its chemical stability, the oil exhibited a **distinct volatile profile** (marked by **acetone** and **2,4-heptadienal**). This adversely impacted the acceptability of French fries, and their appeal diminished progressively following an initial response similar to that of sunflower oil.

In conclusion, **refined wheat germ oil resulted in a viable option for short-term, domestic deep-frying purposes** that provides significant benefits compared to conventional oil.

REFERENCES

1. Rahoveanu et al. (2018). *Land Use Policy*, 71, 261–270; **2.** Squeo et al. (2022). *Foods*, 11(5), 683; **3.** Multari et al. (2019). *Food Research International*, 122, 318–329; **4.** Alkil et al. (2015). *Journal of the American Oil Chemists' Society*, Vol. 92, 3, 409-421; **5.** AOAC, 2011. AOCS official method (method Cd 8-85); **6.** AOAC, 2011. AOCS official method (method Cd 18-90).

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