# Influence of maceration process of selected cold-pressed oils with lyophilized mullein flowers (*Verbascum thapsus* L.) on their oxidative stability and chemical composition

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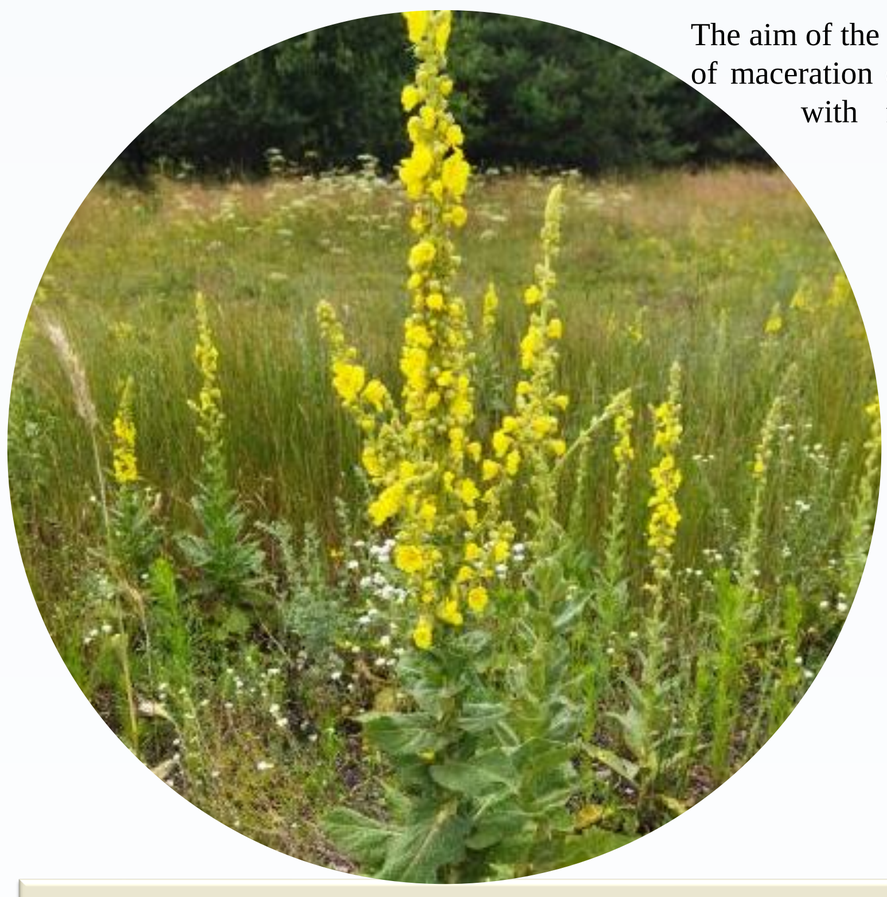
## INTRODUCTION & AIM

Cold-pressed oils are an excellent health solution. Compounds in these products provide antioxidant properties and anti-cancer. Some vegetable oils are characterized by their content polyunsaturated fatty acids, affecting their properties anti-atherosclerotic and hypocholesterolemic. Oil pressing at low temperatures it ensures less loss of valuable health benefits which translates into higher quality of the final product. Unfortunately, a large amount of Polyunsaturated fatty acids makes cold-pressed oils easy to apply to the oxidation process. Oxidation processes in classic oils changes their health-promoting properties and side effects human health. This also results in organoleptic batteries, the oils themselves, as well as prepared from their use. For this reason, it is sought method of limiting oxidative changes in cold-pressed oils, which ensures extending the durability of these products. The use of antioxidants for this purpose origin arises, it is written in the current trend of low-processed food, spray without the use of chemicals. We are currently looking for new ones natural sources of antioxidants. One may **be mullein (*Verbascum* L.)**, a rich source of bioactive substances, e.g., phenolic acids, flavonoids or phytosterols.



The aim of the study was to assess the effect of maceration of selected cold-pressed oils with freeze-dried mullein flowers on their quality andoxidative stability.

## MATERIAL & METHOD

- Cold-pressed oils: rapeseed (RO), linseed (LO), hempseed (HO), chia seeed(CHO), camelina seed (CO). Oils after maceration (1:10, MRO, MLO, MHO, MCHO, MCO).
- Mullein flowers (*Verbascum nigrum* L.) collected near the Kozienicka Forest (Mazovian Voivodeship) in August 2022.

Oils were analysed to their:

- Degree of oil hydrolysis (PN-EN ISO 660:2010)
- Primary oxidation state (PN-EN ISO 3960:2017-03)
- Secondary oxidation state (AOCS Official Method Cd 18-90)
- Total oxidation state (Totox)
- Oxidative stability in Rancimat (3g, 20L/h, 90-140°C)
- Total phenol content (Dewanto et al. 2002)
- Antioxidant activity with DPPH* (Pająk i wsp. 2014) and ABTS* (Akmal i Roy 2017)
- fatty acid composition (AOAC 996.01)
- phenolic acids (Siger et al., 2016),
- calculation of kinetics parameters.

## RESULTS

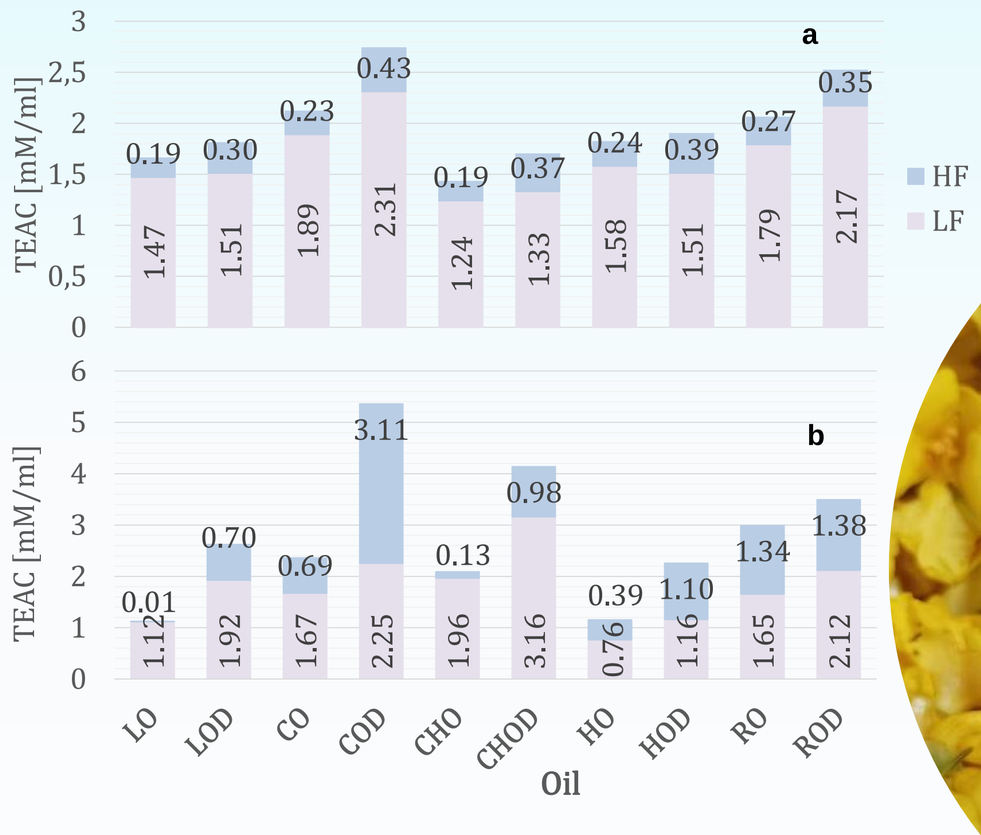



**Figure 1.** Antioxidant activity of analysed oils lipophilic and hydrophilic fraction analysed using DPPH (a) and ABTS (b) method

**Table 1.** Oils' quality characteristics, oxidative stability and phenolic compounds content

| Oil | AV [mg KOH/g] | PV [mEq $O_2$/kg] | P-AnV | Totox | IT at 100°C [h] | TPC [mg GAE/100 g] |
|---|---|---|---|---|---|---|
| **LO** | $1.29^{ab}$ | $1.18^{bc}$ | $0.88^{ab}$ | $3.25^{a}$ | $4.68^{c}$ | $341.95^{abc}$ |
| **LOD** | $1.51^{bc}$ | $2.57^{a}$ | $0.19^{c}$ | $5.34^{ab}$ | $6.04^{d}$ | $379.43^{abc}$ |
| **CO** | $0.84^{a}$ | $0.99^{b}$ | $1.00^{ab}$ | $2.98^{a}$ | $6.06^{d}$ | $558.63^{bc}$ |
| **COD** | $0.73^{a}$ | $2.23^{ac}$ | $0.32^{d}$ | $4.79^{ab}$ | $7.39^{e}$ | $645.94^{c}$ |
| **CHO** | $2.46^{d}$ | $2.18^{abc}$ | $0.94^{ab}$ | $5.30^{ab}$ | $2.25^{a}$ | $291.13^{abc}$ |
| **CHOD** | $2.13^{cd}$ | $2.45^{a}$ | $1.11^{b}$ | $6.01^{b}$ | $3.77^{b}$ | $455.19^{abc}$ |
| **HO** | $2.52^{d}$ | $8.20^{e}$ | $0.79^{a}$ | $17.19^{d}$ | $5.33^{cd}$ | $232.28^{ab}$ |
| **HOD** | $1.68^{bc}$ | $12.90^{f}$ | $3.16^{d}$ | $28.96^{e}$ | $5.16^{cd}$ | $418.16^{abc}$ |
| **RO** | $1.01^{ab}$ | $2.07^{abc}$ | $0.89^{ab}$ | $5.03^{ab}$ | $17.34^{f}$ | $148.02^{a}$ |
| **ROD** | $0.73^{a}$ | $4.16^{d}$ | $0.48^{c}$ | $8.80^{c}$ | $17.71^{f}$ | $387.43^{abc}$ |

**Table 2.** Phenolic acid composition content (µg/100g) of analysed oils

| Compound | OIL | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LO | LOD | CO | COD | CHO | CHOD | HO | HOD | RO | ROD |
| gallic acid | 0.00 | 144.04 | 0.00 | 691.02 | 0.00 | 641.10 | 0.00 | 691.02 | 0.00 | 2523.67 |
| p-hydroxybenzoic acid | 1.49 | 8.14 | 1.21 | 0.00 | 2.91 | 4.75 | 0.00 | 9.14 | 0.00 | 0.00 |
| protocatechuic acid | 0.00 | 17.13 | 0.00 | 9.85 | 4.95 | 11.46 | 0.00 | 26.01 | 0.00 | 0.00 |
| p-coumaric acid | 0.00 | 8.72 | 0.00 | 6.76 | 0.00 | 5.03 | 0.00 | 9.84 | 0.00 | 6.12 |
| ferulic acid | 3.89 | 3.51 | 0.00 | 0.00 | 0.00 | 0.00 | 1.63 | 4.40 | 4.79 | 5.26 |
| sinapic acid | 0.00 | 0.00 | 7.38 | 13.36 | 7.22 | 5.78 | 0.00 | 0.00 | 79.37 | 85.89 |
| **Total** | $5.38^{b}$ | $181.53^{g}$ | $8.59^{c}$ | $720.98^{i}$ | $15.08^{d}$ | $668.10^{h}$ | $1.63^{a}$ | $75.20^{e}$ | $84.16^{f}$ | $2620.93^{j}$ |

**Table 3**. Oxidation kinetic parameters of analysed cold-pressed oils before and after maceration with mullein flowers

| KINETIC PARAMETERS | OILS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LO | LOD | CO | COD | CHO | CHOD | HO | HOD | RO | ROD |
| T coeff [$K^{-1}$] | $7{,}2*10^{-2}$ | $7.7*10^{-2}$ | $7.4*10^{-2}$ | $7.04*10^{-2}$ | $7.07*10^{-3}$ | $7.57*10^{-4}$ | $7.34*10^{-5}$ | $7.64*10^{-6}$ | $6.79*10^{-5}$ | $7.15*10^{-8}$ |
| Z [$h^{-1}$] | $4.69*10^{13}$ | $1.96*10^{14}$ | $6.07*10^{13}$ | $1.67*10^{13}$ | $5.5*10^{13}$ | $2.21*10^{14}$ | $1.10*10^{13}$ | $4.38*10^{13}$ | $7.0*10^{13}$ | $2.01*10^{14}$ |
| Ea [kJ/mol] | 80.72 | 86.21 | 83.53 | 79.13 | 79.47 | 85.03 | 80.45 | 84.76 | 82.59 | 85.86 |
| k at 100 °C [$h^{-1}$] | 0.2137 | 0.1657 | 0.2077 | 0.1343 | 0.4167 | 0.2656 | 0.1878 | 0.1938 | 0.0577 | 0.0565 |
| Q10 | 1.91 | 1.99 | 1.93 | 1.89 | 1.89 | 1.97 | 1.94 | 1.97 | 1.85 | 1.90 |
| ΔH [kJ/mol] | 77.67 | 83.15 | 78.96 | 76.59 | 76.42 | 81.98 | 79.53 | 82.81 | 77.32 | 81.62 |
| ΔS [J/mol K] | -118.77 | -106.89 | -116.63 | -126.13 | -117.44 | -105.87 | -115.43 | -106.65 | -131.06 | -119.55 |
| ΔG at 100 °C [kJ/mol] | 121.97 | 123.02 | 122.47 | 123.63 | 120.23 | 121.47 | 122.59 | 122.59 | 126.20 | 126.22 |
| $IP^{25°C}$ [days] | 14 | 27 | 22 | 25 | 8 | 15 | 21 | 22 | 42 | 50 |
| $IP^{4°C}$ [days] | 54 | 113 | 87 | 95 | 32 | 64 | 85 | 93 | 153 | 190 |

## CONCLUSION

The findings from this research strongly support the conclusion that the addition of mullein flowers can substantially enhance the oxidative stability of cold-pressed oils. The maceration process of oils with mullein flowers also increased the content of bioactive antioxidant compounds. However, further investigation is warranted to deepen our understanding, optimize the maceration parameters, and conduct in-depth analysis of the bioactive compounds involved. These areas of research hold promising potential for further advancements in this field.