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Influence of Edible Flower Extracts on Oxidative Stability of Vegetable Oils

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Abstract

The present study investigates the effect of natural extracts obtained from edible magnolia petals on the oxidative stability and quality parameters of rapeseed and olive oils during storage. Oil samples were enriched with different concentrations (2–20%, v/v) of magnolia extracts (commercial and laboratory-prepared) and monitored over a 21-day period at 7-day intervals. The evaluation included peroxide value, free fatty acids, refractive index, total polyphenol content, antioxidant activity (DPPH), and sensory analysis. The results showed that the addition of magnolia extracts significantly improved the oxidative stability of both oils, as indicated by lower peroxide values and reduced accumulation of free fatty acids compared to control samples.

Among the tested variants, extracts of Magnolia liliiflora exhibited the highest polyphenol content (up to 944.4 mg GAE/100 mL) and antioxidant activity (73% DPPH inhibition), which correlated with enhanced stability of the enriched oil samples. Sensory evaluation indicated that extract addition did not negatively affect visual attributes but contributed to improved aroma and taste in selected samples.

These findings highlight the potential of magnolia petal extracts, particularly Magnolia liliiflora, as natural antioxidants for extending the shelf life and improving the quality of edible oils.

Keywords*: magnolia petal extract; polyphenols; lipid oxidation; antioxidant activity; shelf life*

1. Introduction

In recent years, extending the shelf life of food products while maintaining their quality has become an important focus in the food industry, due to its impact on both consumer health and the sustainability of production processes. Vegetable oils, such as rapeseed and olive oil, play a key role in the human diet; however, they are prone to oxidation and rancidity, processes that can negatively affect their nutritional value and sensory characteristics [1,2].

Rapeseed oil is among the most widely consumed edible oils worldwide, ranking third in global consumption. Its nutritional value is largely attributed to its high content of unsaturated fatty acids, particularly polyunsaturated fatty acids [3]. In addition, rapeseed contains a variety of bioactive compounds, including phenolic acids, phytosterols, flavonoids, and vitamin E, which contribute to its functional properties. Modern rapeseed varieties are also characterized by reduced levels of erucic acid and glucosinolates, improving their safety and suitability for human consumption [4,5].

Olive oil is a vegetable oil obtained from the fruit of the olive tree (*Olea europaea* L., family Oleaceae). Its production, including olive cultivation, harvesting, and oil extraction, has a long-standing tradition and has been closely associated with human societies since ancient times [6]. Olive oil is widely consumed as an important source of dietary fat and has been consistently associated with beneficial health effects. These properties are largely linked to its high content of monounsaturated fatty acids,

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together with the presence of phenolic compounds that contribute to its protective role in human health [7]. The oxidative stability of olive oil is largely influenced by its natural phenolic compounds, a group of secondary metabolites known for their strong antioxidant activity [8]. Olive oil consumption has been associated with antioxidant and anti-inflammatory effects, improved lipid profile, and a reduced risk of several chronic diseases, as well as modulation of the gut microbiota [9]. Recent studies have highlighted that plant-derived bioactive compounds and natural nanovesicles possess significant antioxidant and anti-inflammatory properties, supporting their potential application as natural alternatives for improving food stability and reducing oxidative degradation [10].

Magnolia officinalis has attracted considerable attention due to its complex phytochemical composition, which includes bioactive compounds such as magnolol and honokiol, known for their antioxidant and antimicrobial properties. In addition, it has been traditionally used for its beneficial effects during recovery, particularly in alleviating gastrointestinal discomfort, and has also been reported to exhibit antiviral activity [11]. These compounds are capable of inhibiting lipid oxidation by scavenging free radicals and stabilizing reactive species, making magnolia extracts promising candidates for food preservation applications [12]. Given the susceptibility of edible oils to oxidative degradation, the incorporation of such natural antioxidants represents an effective strategy to enhance their stability and extend shelf life [13].

The protective effect observed in the present study is consistent with previous reports demonstrating that plant polyphenols may reduce oxidative deterioration in lipid-containing foods. Quoc et al. (2021) [14] reported that *Polygonum multiflorum* root extract inhibited lipid oxidation and preserved quality characteristics of ground beef during storage. In this context, the present study aims to evaluate the effect of magnolia extract on the oxidative stability and overall quality of selected vegetable oils.

2. Materials and method

Rapeseed oil and olive oil were obtained from local commercial sources (Brașov, Romania) and used as base matrices for the experimental study. Two types of extracts were used, a commercial magnolia extract (PlantExtrakt, Romania) and a laboratory prepared extract.

Preparation of magnolia flower extract

The extract was obtained by maceration of 700 g of fresh white magnolia flowers (*Magnolia officinalis*) and red magnolia flowers (*Magnolia liliiflora)* collected locally in Romania in 96% ethanol for 24 h at room temperature, with periodic agitation. After maceration, the mixture was filtered through filter paper to remove plant residues, and the obtained extract was transferred into 50 mL sealed tubes and stored, kept in a cool, dark place until further use.

The experimental samples supplemented with different types and concentrations of magnolia extracts, as well as control samples without extract addition, as presented in Table 1.

Table 1. Codification of experimental oil samples enriched with *Magnolia* extracts

Sample code	Oil type	Extract type	Extract volume (mL)	Oil volume (mL)
UR	Rapeseed oil	–	–	50
UR1	Rapeseed oil	Commercial Magnolia officinalis	1	50
UR3	Rapeseed oil	Commercial Magnolia officinalis	3	50
UR5	Rapeseed oil	Commercial Magnolia officinalis	5	50
UR10	Rapeseed oil	Commercial Magnolia officinalis	10	50
URma3	Rapeseed oil	Laboratory-prepared Magnolia officinalis	3	50
URma5	Rapeseed oil	Laboratory-prepared Magnolia officinalis	5	50
URmr3	Rapeseed oil	Laboratory-prepared Magnolia liliiflora	3	50
URmr5	Rapeseed oil	Laboratory-prepared Magnolia liliiflora	5	50
UM	Olive oil	–	–	50
UM1	Olive oil	Commercial Magnolia officinalis	1	50
UM3	Olive oil	Commercial Magnolia officinalis	3	50
UM5	Olive oil	Commercial Magnolia officinalis	5	50
UM10	Olive oil	Commercial Magnolia officinalis	10	50
UMma3	Olive oil	Laboratory-prepared Magnolia officinalis	3	50
UMma5	Olive oil	Laboratory-prepared Magnolia officinalis	5	50
UMmr3	Olive oil	Laboratory-prepared Magnolia liliiflora	3	50
UMmr5	Olive oil	Laboratory-prepared Magnolia liliiflora	5	50

The resulting variants were kept in transparent test tubes at temperatures between 22–25 °C and were re-evaluated at different time intervals. The experimental variants obtained in the laboratory were evaluated by determining the refractive index, free fatty acids (FFA), peroxide value, total polyphenol content, antioxidant capacity, and through sensory analysis

2.1. Determination of the peroxide value.

The peroxide value (PV) was determined using the iodometric titration method. Approximately 5 g of oil sample were dissolved in a mixture of chloroform and glacial acetic acid, followed by the addition of potassium iodide. The liberated iodine, formed from lipid peroxides, was titrated with 0.01 mol L^{-1} sodium thiosulfate solution using starch as an indicator until the disappearance of the blue coloration. The peroxide value was calculated and expressed as milliequivalents of active oxygen per kilogram of oil (meq O_2/kg). This parameter is widely used to assess the primary oxidation of edible oils [15].

$$PV=\frac{(V1-V2)V1\times n}{m}\times 1000$$

where:

- V_1 = volume of sodium thiosulfate solution used for titration of the sample $[cm^3]$
- V_2 = volume of sodium thiosulfate solution used for titration of the blank $[cm^3]$
- m = mass of the analyzed sample $[g]$
- n = normality of the sodium thiosulfate solution used for titration (0.1 or 0.01)

2.2. Determination of free fatty acids (FFA)

Free fatty acids (FFA) are formed as a result of triglyceride hydrolysis during oil processing and storage; therefore, their content is commonly used as an indicator of oil degradation. The acid value was determined by titration with a basic solution in the presence of phenolphthalein as an indicator [16].

For the analysis, approximately 2 g of oil sample were weighed into a 100–150 mL Erlenmeyer flask and dissolved in 15 mL of an ethanol–ether mixture. Two to three drops of phenolphthalein were added, and the solution was titrated with 0.1 N potassium hydroxide under continuous stirring until a stable pale pink color persisted for 1 min.

The acid value was calculated using the following equation:

$$AV = \frac{5.604 \times V}{m}$$

where:

- V = volume of potassium hydroxide solution used for titration (mL);
- m = mass of the sample used for analysis (g);
- 5.604 = mg of potassium hydroxide corresponding to 1 mL of 0.1 N KOH.

The acid value is expressed as mg KOH/g oil and reflects the content of free fatty acids in the sample.

2.3. Determination of refractive index

The refractive index is a physical parameter commonly used to assess the purity and quality of edible oils, as each oil has a characteristic refractive index depending on its chemical composition [17]. The refractive index of the oil samples was measured using an Abbe refractometer (Krüss Optronic GmbH, Hamburg, Germany) at 50°C. A few drops of oil were placed on the clean prism, ensuring uniform coverage and absence of air bubbles, and the refractive index was recorded directly as nD values with a precision of four decimal places.

2.4. Determination of free fatty acids (FFA) using the FoodLab analyzer

The free fatty acid content of the oil samples was determined using a CDR FoodLab® analyzer (CDR FoodLab S.r.l., Florence, Italy). The method is based on a colorimetric reaction between free fatty acids in the sample and a chromogenic reagent, the decrease in absorbance measured photometrically being proportional to the FFA concentration expressed as % oleic acid. The oil sample was homogenized, introduced into the analytical cuvette, and reacted with the specific reagent (R2). The analysis was performed automatically by the instrument and the FFA value was displayed directly by the system [18].

2.5. Determination of total polyphenol content

The total polyphenol content of the magnolia petal extracts was determined using the Folin–Ciocalteu spectrophotometric method [19]. The samples were prepared by mixing 1 mL of extract with 10 mL of ethanol acidified with 1% HCl in centrifuge tubes, followed by vigorous mixing using a Vortex mixer (Heidolph Instruments GmbH & Co. KG, Schwabach, Germany).

For the analysis, 0.5 mL of the prepared solution was transferred into test tubes, and 1.5 mL of Folin–Ciocalteu reagent (diluted 1:10) was added. After 5 min, 2 mL of sodium carbonate solution (7.5%) was added. The mixtures were kept in the dark for 90 min, after which the absorbance was measured at 725 nm using a UV–Vis

spectrophotometer (DR 2800, Hach Lange GmbH, Düsseldorf, Germany).

The total polyphenol content was calculated using the calibration curve of gallic acid (y = ax + b) and expressed as mg gallic acid equivalents per 100 mL of sample (mg GAE/100 mL) according to the following equation:

$$TPC = \frac{(A_{725} - b)}{a} \times \frac{V \times 100}{v}$$

where:

- A_{725} = absorbance measured at 725 nm
- a = slope of the calibration curve (2.1223)
- b = intercept of the calibration curve (0.0744)
- V = volume of ethanol used for extraction (10 mL)
- v = volume of the analyzed sample (1 mL)

2.6. Determination of antioxidant capacity

The antioxidant capacity of the samples was evaluated using the DPPH radical scavenging assay. The measurements were performed spectrophotometrically at 517 nm using a microplate reader (Tecan Sunrise™, Tecan Group Ltd., Männedorf, Switzerland) with Magellan software.

For the assay, 20 µL of extract and 20 µL of distilled water were added to the wells of a 96-well microplate, followed by 200 µL of ethanolic DPPH solution. Negative controls were prepared using 20 µL distilled water instead of extract. The plate was incubated in the dark for 30 min, after which the absorbance was measured at 517 nm [20].

The DPPH radical scavenging activity was expressed as percentage inhibition and calculated using the following equation:

$$\%\ \text{DPPH inhibition} = 100 \times \frac{A_{control} - A_{sample}}{A_{control}}$$

where:

- $A_{control}$ = absorbance of the control (0.892)
- A_{sample} = absorbance of the analyzed sample.

2.7. Sensory evaluation

The sensory evaluation of the experimental oil samples was performed by a small panel of evaluators. Each assessor evaluated the samples using descriptive attributes and assigned scores on a five-point hedonic scale (1–5), where 1 indicated very low intensity or poor quality and 5 indicated very high intensity or excellent quality. The samples were assessed for general sensory characteristics, and the results were recorded in a descriptive evaluation table, allowing comparison and differentiation between the experimental variants.

2.8. Statistical analysis

All analyses were performed in triplicate, and the results were expressed as mean ± standard deviation. Statistical evaluation of the data was carried out using analysis of variance (ANOVA) followed by Tukey's post hoc test to determine significant differences between samples. Differences were considered statistically significant at $p < 0.05$

3. Results

3.1. Results of peroxid value

During the 21-day storage period, the control sample (UR) showed a gradual increase in peroxide value from 0.03 to 0.08, indicating progressive lipid oxidation, as shown in Figure 1. In contrast, the samples enriched with natural extracts generally showed lower peroxide values and a slower evolution compared to the control.

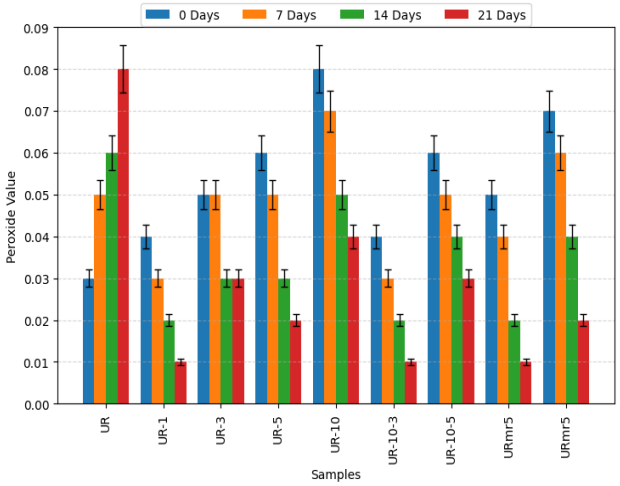

Figure 1. Changes in peroxide value of rapeseed oil samples (UR) during storage

The most evident effect was observed for sample URmr5, which showed the lowest peroxide values, ranging from 0.07 to 0.02 meq O_2/kg.This behavior may be associated with the presence of antioxidant compounds in the extract, which could limit the formation of primary oxidation products. Even though an increase in peroxide value is normally expected during storage, the addition of magnolia extracts appears to have reduced the extent of oxidation.

These results are consistent with the findings of Ansorena *et al.* (2023) [21], who reported that peroxide values increase in rapeseed oil during storage in the absence of antioxidants, similar to the

control sample. Likewise, Amft et al. (2023) [22] showed that oxidative stability of cold-pressed rapeseed oil decreases over time, supporting the observed trend. In contrast, studies on oils enriched with natural extracts demonstrated a reduction in peroxide values and improved oxidative stability, as reported in experimental research on rapeseed oil supplemented with phenolic-rich extracts, where treated samples showed significantly lower peroxide values compared to control oils [23].

As presented in Figure 2, the peroxide values of olive oil samples followed a similar pattern to those observed for rapeseed oil. During the 21-day storage period, the control sample (UM) showed an increase in peroxide value from 0.02 to 0.07, indicating progressive oxidative degradation. In contrast, all samples enriched with natural extracts exhibited a decreasing trend, reflecting improved oxidative stability. Sample UMmr5 showed the lowest peroxide values among the tested variants, which may be related to the antioxidant compounds present in the extract.

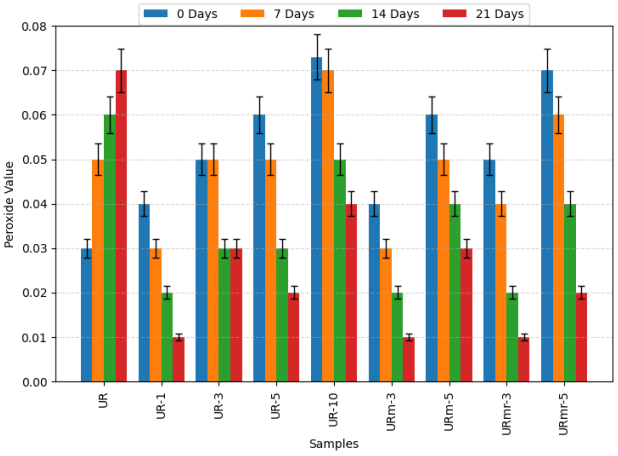

Figure 2. Changes in peroxide value of olive oil samples (UM) during storage

These findings are consistent with experimental studies on olive oil enriched with phenolic compounds. For instance, Markhali *et al.* (2024) [24] demonstrated that olive oil enriched with olive leaf polyphenols showed lower peroxide values compared to control samples during storage, indicating improved oxidative stability. Similarly, experimental studies have shown that the addition of natural extracts to olive oil can significantly reduce peroxide values and improve oxidative stability; for example, the enrichment of olive oil with *Rosmarinus officinalis* essential oil resulted in lower peroxide values compared to the control during storage [25].

3.2. Results of free fatty acids

As shown in Figure 3, the free fatty acid (FFA) content of the rapeseed oil samples decreased over the 21-day storage period. In the case of sample URma5, the free fatty acid values reached lower levels (0.66 to 0.23), which could be related to the presence of stabilizing compounds in the white magnolia extract. This behavior differs from the trend commonly reported in the literature, where FFA levels tend to increase during storage due to triglyceride hydrolysis. For example, Matthäus and Brühl (2003) [26] observed a gradual rise in FFA content in cold-pressed rapeseed oil during storage.

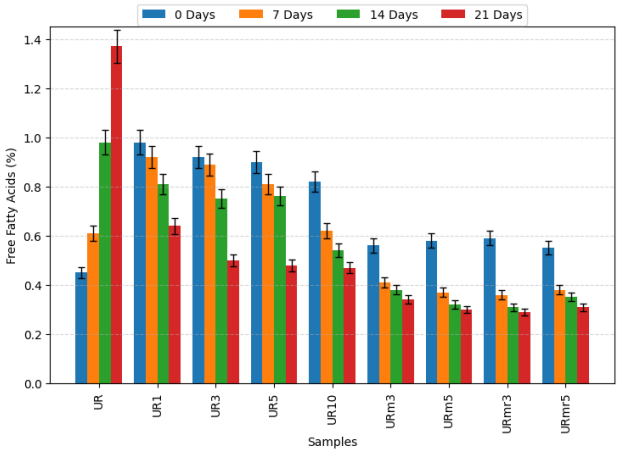

Figure 3. Evolution of free fatty acid content in rapeseed oil samples (UR) over time

Similarly, studies on rapeseed oil stability have shown that storage conditions promote hydrolytic degradation, leading to the accumulation of free fatty acids. In contrast, the decreasing FFA values recorded in this study suggest that the addition of natural extracts may slow down hydrolytic processes and contribute to maintaining oil quality over time [27].

The evolution of free fatty acid (FFA) content in olive oil samples over the 21-day storage period showed a decreasing trend in all samples containing natural extracts, as shown in Figure 4.

In contrast, the samples containing magnolia extracts showed lower FFA values, with the lowest levels observed for sample UMmr3 (0.84–0.22). This behavior may be related to the presence of antioxidant compounds in the extracts, which could contribute to limiting hydrolytic degradation.

A similar pattern was observed in rapeseed oil, where treated samples (URma5) showed a decrease in FFA, whereas the control exhibited a gradual increase. These results suggest that natural extracts contribute to maintaining oil quality during storage.

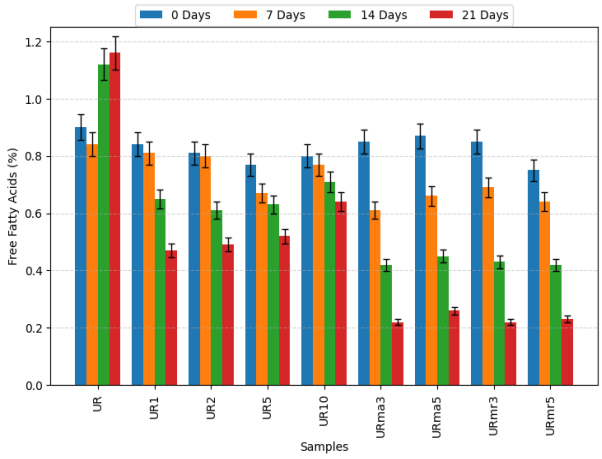

Figure 4. Evolution of free fatty acid content in olive oil samples (UM) over time

In contrast, literature data generally report an increase in FFA content during storage due to hydrolytic processes. For instance, Dabbou *et al.* (2012) [28], observed a rise in FFA values in olive oil under storage conditions while Lerma-García et al. (2009) [29] reported similar trends associated with oil quality deterioration.

3.3. Results of refractive index

The refractive index (RI) values of rapeseed oil samples showed only minor variations during the 21-day storage period as shown in Table 2. A small decrease was observed in all samples containing natural extracts, with the most notable change recorded for sample UR10, where the value decreased from 1.4611 to 1.4588.

Table 2. Refractive index of rapeseed oil samples during storage (mean ± SD)

Sample	0 days	7 days	14 days	21 days
UR	1.4594 ± 0.0002^{c}	1.4598 ± 0.0002^{c}	1.4607 ± 0.0003^{b}	1.4612 ± 0.0003^{a}
UR1	1.4612 ± 0.0003^{a}	1.4613 ± 0.0002^{a}	1.4596 ± 0.0002^{b}	1.4594 ± 0.0003^{b}
UR3	1.4609 ± 0.0002^{a}	1.4596 ± 0.0002^{b}	1.4592 ± 0.0002^{c}	1.4592 ± 0.0003^{c}
UR5	1.4602 ± 0.0003^{a}	1.4596 ± 0.0002^{b}	1.4591 ± 0.0002^{c}	1.4587 ± 0.0003^{d}
UR10	1.4611 ± 0.0002^{a}	1.4599 ± 0.0002^{b}	1.4598 ± 0.0003^{b}	1.4592 ± 0.0003^{c}
URma3	1.4603 ± 0.0002^{a}	1.4595 ± 0.0003^{b}	1.4593 ± 0.0002^{c}	1.4588 ± 0.0003^{d}
URma5	1.4608 ± 0.0003^{a}	1.4603 ± 0.0002^{b}	1.4596 ± 0.0002^{c}	1.4593 ± 0.0002^{c}
URmr3	1.4601 ± 0.0002^{a}	1.4594 ± 0.0002^{b}	1.4589 ± 0.0003^{c}	1.4586 ± 0.0003^{c}
URmr5	1.605 ± 0.0002^{a}	1.4599 ± 0.0003^{b}	1.4595 ± 0.0002^{c}	1.4591 ± 0.0003^{c}

Values are expressed as mean ± standard deviation (n = 3). Different superscript letters within the same row indicate statistically significant differences according to Tukey's test ($p < 0.05$).

In contrast, the control sample showed a slight increase from 1.4594 to 1.4612, suggesting a gradual deterioration of oil quality in the absence of added extracts.

In the literature, variations in refractive index are associated with oxidative processes and changes in the chemical composition of oils during storage. The refractive index is widely used as an indicator of oil quality, reflecting structural modifications caused by degradation reactions [16]. Experimental studies have also shown that oxidation and processing conditions can lead to slight increases in refractive index values due to the formation of secondary oxidation products [30].The results suggest that natural extracts help maintain oil stability during storage. The refractive index (RI) of olive oil samples showed only small variations during storage. Samples enriched with natural extracts generally presented lower refractive index values during storage, with the greatest variation recorded for UMma5 (1.4601–1.4563). In contrast, the control sample increased from 1.4581 to 1.4615, indicating a gradual loss of quality as presented in Table 3.

A similar increase in refractive index during oil degradation was reported by Bascuñan et al. (2026) [31], who observed that oxidation processes are accompanied by higher RI values. A comparable pattern was also observed in the control sample of the present study. However, the decrease observed in the extract-enriched samples suggests that these oxidative changes were limited.

Comparable results have also been described in other studies, where storage led to increases in refractive index due to structural changes in lipids [32]. In this case, the lower values recorded for the treated samples point to a better preservation of the oil, most likely due to the presence of antioxidant compounds.

Table 3. Refractive index of olive oil samples during storage (mean ± SD)

Sample	0 days	7 days	14 days	21 days
UM	1.4581 ± 0.0003^{c}	1.4589 ± 0.0002^{b}	1.4599 ± 0.0002^{b}	1.4615 ± 0.0003^{a}
UM1	1.4609 ± 0.0002^{a}	1.4594 ± 0.0002^{b}	1.4586 ± 0.0002^{c}	1.4578 ± 0.0003^{d}
UM3	1.4606 ± 0.0003^{a}	1.4592 ± 0.0002^{b}	1.4588 ± 0.0002^{c}	1.4579 ± 0.0002^{d}
UM5	1.4604 ± 0.0002^{a}	1.4595 ± 0.0002^{b}	1.4583 ± 0.0002^{c}	1.4576 ± 0.0003^{d}
UM10	1.4603 ± 0.0002^{a}	1.4594 ± 0.0002^{b}	1.4581 ± 0.0002^{c}	1.4572 ± 0.0003^{d}
UMma3	1.4605 ± 0.0002^{a}	1.4593 ± 0.0002^{b}	1.4579 ± 0.0002^{c}	1.4569 ± 0.0003^{d}
UMma5	1.4601 ± 0.0002^{a}	1.4589 ± 0.0002^{b}	1.4576 ± 0.0002^{c}	1.4563 ± 0.0003^{d}
UMmr3	1.4607 ± 0.0002^{a}	1.4596 ± 0.0002^{b}	1.4585 ± 0.0002^{c}	1.4573 ± 0.0003^{d}
UMmr5	1.4602 ± 0.0002^{a}	1.4591 ± 0.0002^{b}	1.4587 ± 0.0002^{c}	1.4581 ± 0.0002^{c}

Values are expressed as mean ± standard deviation (n = 3). Different superscript letters within the same row indicate significant differences according to Tukey's test ($p < 0.05$).

3.4. Results of polyphenol content

The total polyphenol content varied significantly among the analyzed extracts. The highest values were recorded for *Magnolia liliiflora* (2.079 ± 0.020; 944.4 ± 8.6 mg GAE/100 mL), followed by the commercial *Magnolia officinalis* extract (1.654 ± 0.145; 712.6 ± 6.8 mg GAE/100 mL), while the lowest values were observed for the laboratory *Magnolia officinalis* extract (1.221 ± 0.301; 540.3 ± 5.2 mg GAE/100 mL), as shown in Table 4.

Table 4. Total polyphenol content of magnolia extracts

Sample code	Absorbance at 725 nm (mean ± SD)	TPC (mg GAE/100 mL sample)
Magnolia officinalis (laboratory extract)	1.221 ± 0.301^{c}	540.3 ± 5.2^{c}
Magnolia officinalis (commercial extract)	1.654 ± 0.145^{b}	712.6 ± 6.8^{b}
Magnolia liliiflora, (laboratory extract)	2.079 ± 0.020^{a}	944.4 ± 8.6^{a}

Values are expressed as mean ± standard deviation (n = 3). Different superscript letters (a–c) indicate statistically significant differences according to ANOVA followed by Tukey's test ($p < 0.05$). TPC – total polyphenol content expressed as gallic acid equivalents (GAE).

These differences indicate that both plant source and extraction conditions influence the phenolic content. The lower variability observed for *Magnolia liliiflora* suggests good repeatability, whereas the higher standard deviation in the laboratory *Magnolia officinalis* extract may reflect differences in extraction efficiency.

Similar variations in polyphenol content have been reported in the literature, depending on plant species and extraction conditions. For instance, hydroalcoholic extracts of *Magnolia officinalis* have been reported to reach values of approximately 98 mg GAE/g, with clear differences between plant parts and extraction conditions [11]. In the present study, a similar variability was observed, with values ranging from 540.3 to 944.4 mg GAE/100 mL.

In addition, studies focused on *Magnolia liliiflora* have confirmed that this species contains high levels of phenolic compounds (around 94 mg GAE/g) together with significant antioxidant activity [33]. Compared to these data, the higher values obtained in the present study (up to 944.4 mg GAE/100 mL) further support the strong phenolic profile of this species and its potential effectiveness as a natural antioxidant source.

3.5. Results of antioxidant activity

The antioxidant activity of the Magnolia extracts, evaluated by the DPPH assay (Table 5), showed clear differences between the analyzed samples. The highest radical scavenging activity was recorded for *Magnolia liliiflora* (laboratory extract), with a DPPH inhibition of 73.0%, followed by the commercial *Magnolia officinalis* extract (58.5%), while the lowest value was observed for the laboratory *Magnolia officinalis* extract (44.0%). These differences are also reflected in the absorbance values at 517 nm, where the *Magnolia liliiflora* extract showed the lowest absorbance (0.054), indicating a higher capacity to neutralize free radicals compared to the control (0.199).

The statistical grouping confirms significant differences between samples ($p < 0.05$), suggesting that both the botanical source and extraction conditions influence antioxidant activity. The higher

inhibition percentage observed for *Magnolia liliiflora* is consistent with its higher total polyphenol content, indicating a direct relationship between phenolic concentration and antioxidant capacity.

Comparable levels of antioxidant activity have been reported for *Magnolia* species in previous studies. For instance, a study on *Magnolia grandiflora* flower extracts showed DPPH inhibition values of approximately 63–72%, depending on the extraction solvent, with higher activity associated with higher phenolic content [33]. These values are close to those obtained in the present study, particularly for *Magnolia liliiflora* (73.0%), supporting the strong antioxidant potential of Magnolia flower extracts.

In contrast, lower DPPH inhibition values have been reported for other Magnolia species under different extraction conditions. *Magnolia alba* extracts showed a maximum DPPH inhibition of around 36%, indicating weaker antioxidant activity [34]. Compared to these data, the values obtained in the present study (44.0–73.0%) are higher, suggesting that the extracts used here, especially *Magnolia liliiflora*, have a stronger radical scavenging capacity.

Table 5. Antioxidant activity of magnolia extracts determined by the DPPH assay (% radical inhibition)

Sample code	DPPH inhibition (%)	Control absorbance (517 nm)
Magnolia officinalis, (laboratory extract)	44.0^{c}	0.199
Magnolia officinalis, (commercial extract)	58.5^{b}	0.199
Magnolia liliiflora, (laboratory extract)	73.0^{a}	0.199

Values represent the percentage inhibition of DPPH radicals. Different superscript letters (a–c) indicate statistically significant differences according to ANOVA followed by Tukey's test ($p < 0.05$).

3.6. Results of sensory evaluation

The sensory properties of the experimental samples were evaluated by a consumer-type panel of 50 people using a 5-point scale. The sensory evaluation of rapeseed oil samples showed that the addition of natural extracts did not significantly affect appearance, color, or consistency, with scores remaining similar to the control (4.6–5.0), as presented in Figure 5.

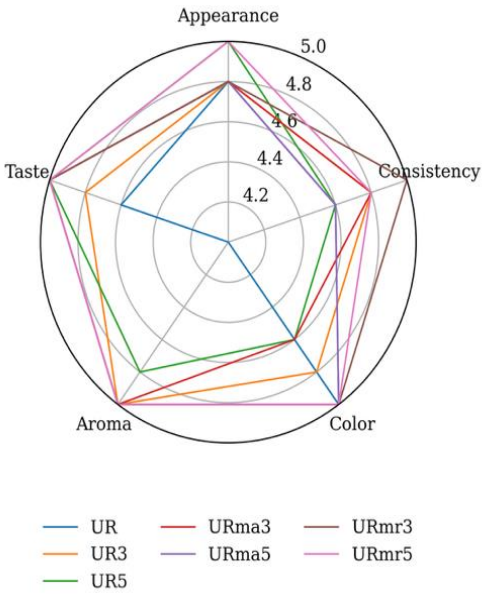

Figure 5. Sensory profile of rapeseed oil samples (UR) enriched with magnolia extracts

In contrast, aroma and taste were clearly influenced, with the highest scores recorded for URmr3 and URmr5 (≈5.0), while UR3 and UR5 showed lower acceptability.

A similar study by Jiang *et al.* (2024) [35] reported that processing conditions and the presence of bioactive compounds significantly influence the flavor and overall sensory quality of rapeseed oil, with samples richer in phenolic compounds showing improved sensory characteristics, particularly aroma and taste . This is consistent with the present results, where samples expected to contain higher levels of bioactive compounds (URmr3, URmr5) received the highest sensory scores.

In another study, Guo *et al.* (2022) [36] used quantitative descriptive analysis (QDA) to evaluate rapeseed oil and showed that aroma-related attributes are key factors in consumer preference, being strongly correlated with the presence of volatile and phenolic compounds. This supports the findings of the present study, where differences between samples were mainly observed in aroma and taste, while visual attributes remained largely unchanged.

The sensory evaluation of olive oil samples showed that aroma and taste were the most affected attributes, with the highest scores recorded for UMmr3 and UMmr5 (≈5.0), while appearance, color, and consistency remained relatively unchanged (4.4–5.0), as shown in Figure 6.

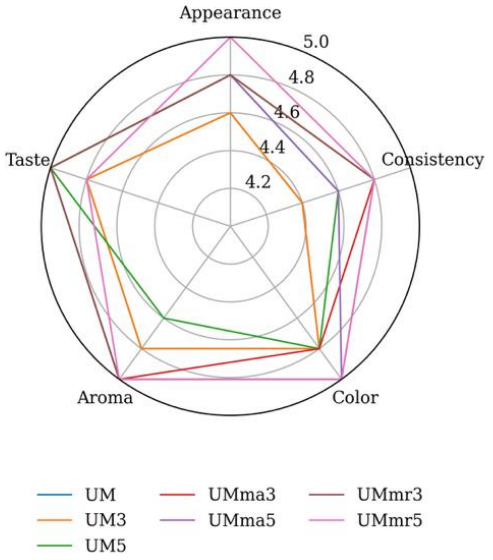

Figure 6. Sensory profile of olive oil samples (UM) enriched with magnolia extracts

Samples UM3 and UM5 showed lower acceptability, mainly due to texture.

A similar study by García-Pizarro *et al.* (2025) [37] reported that sensory evaluation of olive oil is primarily driven by attributes such as fruitiness, bitterness, and aroma, which are closely related to the presence of volatile and phenolic compounds . In that study, oils with more intense sensory profiles were rated higher by trained panels, which is consistent with the present results, where samples with added extracts (UMmr3, UMmr5) received the highest scores for aroma and taste.

In another study, Suurmets *et al.* (2024) [38] showed that flavor and taste are key factors influencing consumer perception and preference in olive oil, with these attributes having a stronger impact than visual characteristics. This supports the findings of the present study, where differences between samples were mainly observed in aroma and taste, while appearance-related attributes remained relatively constant.

4. Conclusion

The addition of magnolia petal extracts influenced the stability of both rapeseed and olive oils during storage. Compared to control samples, the enriched variants generally showed lower peroxide values, lower free fatty acid levels, and smaller variations in refractive index, suggesting a slower progression of oxidative and hydrolytic processes.

Differences between the tested extracts were clearly observed. *Magnolia liliiflora* exhibited the highest polyphenol content and antioxidant activity (73% DPPH inhibition), which was also reflected in the behavior of the enriched oil samples, where changes during storage were less pronounced.

From a sensory perspective, the addition of extracts did not significantly affect visual attributes, but influenced aroma and taste. Samples containing *Magnolia liliiflora* extract were generally better evaluated, indicating a positive effect on overall acceptability.

Overall, the results suggest that magnolia petal extracts, particularly *Magnolia liliiflora*, may represent a natural alternative for improving the stability and quality of edible oils.

Further studies are needed to evaluate the long-term stability of these systems under different storage conditions and to better understand the interactions between magnolia-derived compounds and the lipid matrix.

Conflicts of interest / Competing interests: No conflict of interest

Ethics approval: No ethic situation.

Availability of data and material: The original data and contributions generated during this study are presented within the article. Additional information may be obtained from the corresponding authors upon reasonable request.

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