Vegetal extracts that are used for the protection of the polymers used as food packing material

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Abstract

In order to delay or to avoid the process of polymer degradation, stabilizing agents are incorporated in their mass. The phenolic or aminic stabilizing agents that are used can alter food composition and its properties, that’s why it is so important to use natural compounds with antioxidant properties. In a lot of plants, we find synthesized natural compounds with proven antioxidant properties that can be used for stabilizing the polymers, avoiding food contamination with unwanted products. This paper presents the antioxidizing capacity of some vegetal extracts, obtained from the Laminaceae family that have been tested using paraffin as model system and that contain natural compounds that are efficient in capturing free radicals. In order to compare the antioxidant effect, the phenolic synthesis compound TOPANOL – OC has been used as standard. The results show that we can successfully replace the synthesis stabilizing agents with natural compounds, hence obtaining ecological packing.

Keywords: packing food, antioxidants, chemiluminescence, infrared spectroscopy, spectroscopy in UV – VIS.

1. Introduction

In the plastic material used in packing food, there are some addition agents (antioxidants, plasticizers, colorants, etc.) that can dissolve and diffuse in that food, altering its composition and its conservation deadline.

Antioxidants are substances used for delaying the polymer degradation process by: self-oxidizing, thermo-oxidizing, photo-oxidizing and radio-oxidizing degradation. For the classical methods of polymer stabilizing, there are being used some phenolic antioxidants (phenolic compounds with chalcone-like structure for steric hindrance) and some aminic antioxidants (secondary aromatic ammines) – synthesis compounds that proved to be a carcinogen.

Using natural antioxidants for stabilizing some polymers used in packing food represents a modern, needed and actual preoccupation in order to obtain ecological food packing (EU recommendation). We mention some of the natural antioxidant compounds: carotenoids, vitamin C and E, polyphenolic compounds (flavonoids, polyphenolcarboxilic acids, and tannins).

2. Materials and methods

Vegetal material and extraction process.

The main plant species from which we obtained the extracts are sage, rosemary, oregano, basil, tanner’s sumach. The extracts have been realized by maceration in ethanol (1 part – plant / 10 parts – solvent) for 5 days at room temperature – cold extraction. After being filtered, the solution has been dry evaporated using a vacuum-air pump. The oxidation substrate was paraffin. This was added with 0.25% w/w. The components were stirred by mixing them with ethylene trichloride.

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In order to compare the antioxidant effect, we used as etalon the phenolic compound TOPANOL-OC (2,6-di-t-butyl-4methyl-phenol).

Investigation techniques and instruments.
- Chemiluminescence (CL instrument OL – 94);
- Infrared spectroscopy (FT-IR instrument JASCO 4000); range: 4000-400 cm$^{-1}$
- Spectroscopy in UV – VIS (JASCO V570);

3. Results and discussions

After evaporation, the samples have been used for measuring isothermal chemiluminescence in air (163° C).

Figure 1 presents the CL curves of the mentioned samples from which we obtained the data in Table 1.

![Figure 1](image.png)

Table 1. The kinetic parameters for the oxidation (163° C, air) of the paraffin added (with 0,25% w/w) with Lamiaceae family plant extract. CL data.

<table>
<thead>
<tr>
<th>Extract</th>
<th>$t_i$  (min)</th>
<th>$t_{1/2}$ (min)</th>
<th>$V_{ox}^{\text{max}}$ (u.r./g min)</th>
<th>$I_{\text{max}}$ (u.r./g)</th>
<th>$t_{\text{max}}$ (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>22</td>
<td>56</td>
<td>958</td>
<td>56634</td>
<td>95</td>
</tr>
<tr>
<td>Salvia Officinalis (Sage)</td>
<td>242</td>
<td>302</td>
<td>113</td>
<td>18937</td>
<td>375</td>
</tr>
<tr>
<td>Rosmarinus Officinalis (Rozmary)</td>
<td>163</td>
<td>220</td>
<td>277</td>
<td>25636</td>
<td>300</td>
</tr>
<tr>
<td>Rhus Typhia (Tanner’s sumach)</td>
<td>143</td>
<td>184</td>
<td>452</td>
<td>38398</td>
<td>235</td>
</tr>
<tr>
<td>Origanum Vulgaris (Oregano)</td>
<td>70</td>
<td>90</td>
<td>769</td>
<td>32965</td>
<td>130</td>
</tr>
<tr>
<td>Ocimum Basilicum (Basil)</td>
<td>39</td>
<td>79</td>
<td>465</td>
<td>27525</td>
<td>130</td>
</tr>
</tbody>
</table>

Table 1 presents the kinetic parameters of the chemiluminescence from the paraffin sample stabilized with the Lamiaceae family plant extract.

As it can be observed, there is a considerable increase in the time parameters ($t_i$, $t_{1/2}$, and $t_{\text{max}}$) by adding to the paraffin the mentioned extracts, and there are also lower values for the oxidizing rate. These are clear proofs of the antioxidant effect of the analysed extracts.

We must underline the remarkable antioxidant effect in Salvia Officinalis (Sage) shown by the large induction period (242 minutes) and Rosmarinus Officinalis (Rozmary) with induction period (163 minutes).

This parameter is superior to the one registered in the phenolic compound with steric hidrance TOPANOL-OC recommended as etalon in several other studies. (Figure 2 and Table 2)
Figure 2. The CL curves (163°C, air) of the non stabilized paraffin and of the stabilized paraffin (with 0,25 %) with TOPANOL - OC (2,6-di-t-butyl-4methyl-phenol)

Table 2 The kinetic parameters for the oxidation (163°C, air) of the paraffin added (with 0,25 % w/w) with TOPANOL - OC.

<table>
<thead>
<tr>
<th>The sample</th>
<th>t (min)</th>
<th>t1/2 (min)</th>
<th>V_{ox}^{max} (u.r./g min)</th>
<th>I_{max} (u.r./g)</th>
<th>t_{max} (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean paraffin</td>
<td>22</td>
<td>56</td>
<td>958</td>
<td>56634</td>
<td>95</td>
</tr>
<tr>
<td>Paraffin with</td>
<td>133</td>
<td>164</td>
<td>285</td>
<td>20100</td>
<td>230</td>
</tr>
<tr>
<td>TOPANOL-OC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As this table shows it, Salvia Officinalis (Sage), Rosmarinus Officinalis (Rozmary) and Rhus Typhia (tanner’s sumach) are the plants from which we obtained the extracts that led to the highest paraffin oxidation induction times and to the lowest oxidation rates. This proves the antioxidant characteristic of these extracts; in all of them, the Salvia Officinalis extract manifests the strongest antioxidant characteristic. Thus, compared to the etalon TOPANOL-OC, the extract present a relative activity of 1,982 (Salvia Officinalis), 1,270 (Rosmarinus Officinalis), 1,090 (Rhus Typhia), 0,432 (Origanum Vulgaris) and 0,153 (Ocimum Basilicum). Simultaneously, these extracts lead to subunitary values for the relative oxidizing rate, therefore proving a certain antioxidant activity even after the end of the induction period and the beginning of oxidization.

Hence, the relative oxidizing rate has the values 0,118 (Salvia Officinalis), 0,289 (Rosmarinus Officinalis), 0,472 (Rhus Typhia), 0,803 (Origanum Vulgaris) and 0,485 (Ocimum Basilicum). The remarkable behavior of the antioxidant activity in these extracts can be explained by the presence of some natural poliphenols, highly efficient in capturing free radicals. Hence, the carnosic, chlorogenic, p-cumaric, ferulic, rosmarinic and salvianolic acids, constituents in these extracts, are efficient chain breaking antioxidants.

**IR absorption spectra**

The analysis in the IR spectra (4000 – 400 cm⁻¹) of the obtained extracts has been done in the solid state using ATR. Their spectra have been compared to that of some flavonoids and phenolic acids. The flavonoids have in the IR spectrum a large number of absorption, the most important being the following peaks:

- 3500 – 3330 cm⁻¹; \( \nu_{\text{OH}} \) associated;
- 1660 -1520 cm⁻¹; \( \nu_{\text{C=O}} \) different aromatic substitution;
- 1500- 1300 cm⁻¹; \( \nu_{\text{C=O}} \) and \( \delta_{\text{CHOH}} \);
- 1300 -1100 cm⁻¹; \( \nu_{\text{C-O}} \) (aromatic ethers) + Ar-OH;
- 1100 - 1000 cm⁻¹; \( \nu_{\text{CH-O-O}} \) γ-C-C;
- 1000 - 700 cm⁻¹ different aromatic substitution;

These spectra have been compared to those of the flavonoids and some phenolic acids considered as standard, evidenced the aromatic structures (255 – 270 nm) and the chromopherous groups >C=O and the –OH groups (280 – 370 nm).

Therefore the peaks in the 210 – 310 nm range are due to the phenolic group, and those in the 255 – 280 nm range are specific to the flavonoids.

**UV-VIS absorption spectra**

The absorption spectra in UV–VIS range from the investigated plant extracts are presented in Figure 5 and 6.

These spectra have been compared to those of the flavonoids and some phenolic acids considered as standard, evidenced the aromatic structures (255 – 270 nm) and the chromopherous groups >C=O and the –OH groups (280 – 370 nm).

Therefore the peaks in the 210 – 310 nm range are due to the phenolic group, and those in the 255 – 280 nm range are specific to the flavonoids.

*Figure 3. IR(ATR) spectrum from Salvia Officinalis (Sage) extract (solid sample)*

*Figure 4. IR (ATR) spectrum from Rosmarinus Officinalis (Rozmary) extract (solid sample)*

*Figure 5. UV – VIS spectrum from the alcoholic extract of Salvia Officinalis (Sage) (1:24)*

*Figure 6. UV – VIS spectrum from the alcoholic extract of Rosmarinus Officinalis (Rozmary) (1:24)*
4. Conclusions

- There has been done the characterization of some alcohol extracts from different plants by using the isotherm CL, the IR and UV-VIS absorption spectroscopy;
- The obtained results underline the significant part played by the polyphenolic vegetal structures in obtaining significant antioxidant effects upon polymeric substrates used in the food packing industry;
- The natural antioxidants introduced in the polymers which are being used in making the food packing films avoid contaminating food with the traditional phenolic antioxidant used in packing, antioxidants which migrate by diffusion at room temperature.

References

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