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ANTIRADICAL ACTIVITIES OF *SALVIA OFFICINALIS* AND *VISCUM ALBUM* L. EXTRACTS CONCENTRATED BY ULTRAFILTRATION PROCESS

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Background. In the present study the antioxidant properties were investigated of the medicinal plants *Salvia officinalis* L. (*Labiaceae* family) and *Viscum album* L. (*Loranthaceae*), both of them known for a long time as a remedy in the traditional medicine. The aim of this study was to prove the efficiency of ultrafiltration process for the concentration of herbs extracts and to evaluate the concentrate's antioxidant activity.
Material and methods. The extracts were prepared by maceration, using different solvents. After filtering the extract through Isolab quantitative filter paper "medium", each of the filtrates was processed by microfiltration (MF; Millipore filters with 45 μm), followed by ultrafiltration (UF). The regenerated cellulose (Millipore), polysulfone and polyacrylonitrile ultrafiltration membranes were used in the experiment. The initial extracts and samples of permeate and retentate after ultrafiltration of extracts have been characterized by determination of the protein total and total phenolic content. Standard methods like ABTS and DPPH assay are used to measure the antioxidant activity.
Results. For the three types of tested membranes: Millipore, PSF and PAN, PAN membrane proves to have the greatest efficiency since it shows the highest permeate flux and the greatest retention degree for bioactive compounds. The concentrated extracts obtained after ultrafiltration with polyacrylonitrile membrane had the strongest scavenging activity for all extracts.
Conclusions. The results of this study has revealed that the concentrated extracts have a very high radical scavenging activity (TEAC values for sage hydro-alcoholic concentrated extracts in range 351.87-479.04 μmol Trolox/mL extract and for mistletoe concentrated extract E2 in range 345.14-426.18 μmol Trolox/mL extract; the DPPH inhibition values was over 85% for *S. officinalis* concentrated extracts and ranges between 66.2% and 88.2% DPPH inhibition for *V. album* concentrated), therefore can be considered as a good source for further medicinal applications.

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Key words: *Salvia officinalis*, *Viscum album*, ultrafiltration, antioxidant activity, ABTS, DPPH

INTRODUCTION

The therapeutic effects of several plants and vegetables, used in traditional medicine, are mainly attributed to their antioxidant compounds. Antioxidant substances block the action of free radicals which are involved in pathogenesis of many diseases including atherosclerosis, ischemic heart disease, Alzheimer's disease, Parkinson's disease, cancer and in the aging process [Aruoma 2003]. With this respect, in the late years, considerable attention has been paid to plant sources as antioxidants.

In the present study we investigated the antioxidant properties of the medicinal plants *Salvia officinalis* L. (*Labiaceae* family) and *Viscum album* L. (*Loranthaceae*), both of them known for a long time as a remedy in the traditional medicine. Considerable investigations on *V. album* have come to light its pharmacological properties and determined the chemical constituents which are well known for their antioxidant properties and hepato-protective effects, especially in the leaves and twigs [Bojor and Popescu 2004, Orhan et al. 2005, Adsersen et al. 1997]. The main active compounds of the *Viscum album* extract are proteins (mistletoe lectins or viscolectins, ML), viscotoxins, oligo- and polysaccharides, alkaloids and polyphenolic compounds [Ochocka and Piotrowski 2002, Becker and Exner 1980, Gabius et al. 1989]. The main antioxidant activity of sage (*Salvia officinalis*) was reported to be attributed mainly to carnosic acid, carnosol, and rosmarinic acid [Cuvelier et al. 1997]. However, the chemical components of sage are very complex. Many components such as diterpenes, triterpenes, and flavonoids have been isolated from sage [Länger et al. 1991, Cuvelier et al. 1994, Djarmati et al. 1992].

A serial of major inconveniences such as: high energy consumption, low separation rate, heat sensitive substances being easily decomposed, compound' characteristics being easily affected and serious pollution of the production environment has been identified for medicinal plant extracts' concentration and purification when traditional methods are used.

Membrane separation processes have been extensively studied and developed for their application in biotechnological field [Xu and Wang 2005, Omosaiye and Cheryan 2006, Mulder 1996].

Though there are many literatures on antioxidant activity of sage and mistletoe [Onay-Ucar et al. 2006], the objective of our study is to prove the efficiency of ultrafiltration process for the concentration of herbs extracts and to evaluate the concentrate's antioxidant activity. Standard methods like ABTS and DPPH assay are used to measure the antioxidant activity.

MATERIALS AND METHODS

Chemicals and equipments

ABTS (2,2'-azinobis (3-ethylbenzothiazoline-6-sulfonic acid) diammonium salt, potassium persulfate, Trolox (6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid), DPPH (2,2-diphenyl-1-picrylhydrazyl) were purchased from the Sigma-Aldrich (Germany). Folin-Ciocalteu's phenol reagent, Methanol, Albumin from bovine serum and Gallic acid were from Fluka (Switzerland), Sodium carbonate and Natriumhydroxid were from Roth (Carl Roth GmbH, Germany). Polysulfone (average molecular weight 22,000 Da) and polyacrylonitrile were supplied by Sigma-Aldrich Co., USA, were used as the base polymer in the membrane casting solution. N,N-Dimethylformamide (DMF) was supplied from Merck (Germany). All other chemicals used were of the highest purity grade available.

Microfiltration membrane with 0.45 μm pores and ultrafiltration membrane from cellulose regenerated (cut-off 5,000 Da) were purchased from Millipore (SUA) and membrane from polysulphone (PSF) and polyacrylonitrile (PAN) were prepared in laboratory. The medicinal plants (*Salvia officinale* and *Viscum album* L.) were obtained from a provider specialized in medicinal and aromatic plants – Phytogentec srl (Romania). GRINDOMIX GM200 mill (Retsch – Germany), KMS Laboratory Cell CF-1 acquired from Koch Membrane – Germany.

Preparation and concentration of extracts

The extracts were prepared by maceration, using the cold distillate water and ethylic alcohol (50% v/v) as solvents for *Salvia* and the cold distillate water (E1) and distillate water at 60°C (E2) as solvent for *Viscum album* L. The herbal was ground into powder using mill equipment; the contact time between the herbal and the solvent was 24 hours, with sporadic mechanically stirring, for aqueous extracts and 7 days for hydro alcoholic extract. The herbal's mass concentration in the solvent was of 8% (w/v). After filtering the extract through Isolab quantitative filter paper "medium", each of the filtrates was processed by microfiltration (MF; Millipore filters with 45 μm), followed by ultrafiltration (UF). Finally, after ultrafiltration it results two fractions: permeate (clear extract) and retentate; the permeate contains low molecular weight components at approximately the same concentration as they are in the feed, and the retentate contains large molecular weight components (e.g. proteins, polysaccharides) at an increased concentration compared to the feed. The concentration ratio of extracts (expressed as a volumetric ratio between the permeate and retentate) was 2:1. The used installation for micro- and ultrafiltration was the KMS Laboratory Cell CF-1. Three flat sheet regenerated cellulose (Millipore), polysulfone (PSF) and polyacrylonitrile (PAN) membranes were used in the experiment, each having an effective area of 0.0028 m^2. The permeate flux for each membrane was calculated with formula:

$$J = \frac{V}{A \cdot t} \ (Lm^{-2}h^{-1}) \tag{1}$$

where:

V – the permeate volume (L),

A – the effective membrane area, m^2,
t – the time (h) necessary for the V liters of permeate to be collected.

We measured the time necessary for 100 mL of permeate to be collected and then we calculated the flux.

Membrane preparation

Flat sheet PSF and PAN-based ultrafiltration membrane was prepared by phase inversion method [Parvulescu et al. 2007]. The two polymers (PSF and PAN) were dissolved in the DMF to make the casting solution. The polymer solution was then applied as a film with the help a "doctor blade" knife, followed by the polymer precipitation in the coagulation bath, at laboratory level. The polymer concentration was kept constant at 12%.

Determination of total protein and total phenols content in extracts

The initial extracts and samples of permeate and retentate after ultrafiltration of extracts have been characterized by determination of the total content protein using UV-VIS spectrometry, through the Lowry method [Dumitru and Iordachescu 1988]. The phenolic total content was determined by the Folin-Ciocalteu method [Singleton et al. 1999]. Gallic acid (0-100 mg/L) was used to calibrate the standard curve. Phenolic total content was expressed as milligrams of Gallic acid equivalent (mg GAE)/mL of plant material. All determinations were performed in triplicate. The extracts color did not interfer with the absorbance measurements (at 660 nm and 760 nm) because the absorbance's specific color is in range 230-300 nm.

Retention factor defines the efficiency of biological compounds separation from the feeding solution, % *R*, is calculated from the equation:

$$R = \left[1 - \frac{C_p}{C_f}\right] \cdot 100 \qquad (2)$$

where:

C_p and C_f – the concentrations of the given component in the permeate and the feed, respectively.

Determination of the antioxidant activity

In order to determine the antioxidant activity of extracts two spectrophotometric methods have been applied: ABTS and DPPH methods.

ABTS cation radical-scavenging assay

The total antioxidant activity values of the extracts have been measured by the method Rice-Evans et al. [1995] modified by Litescu and Radu [2000] and is based on the scavenging ability of antioxidants on the long-life radical anion $ABTS^+$. Aliquots of sample extracts (0.1 mL) were added to 2.5 mL of a ABTS solution ($7 \cdot 10^{-3}$ M in potassium persulphate $2.5 \cdot 10^{-3}$ M dissolved in water) and 0.4 mL distilled water. The mixture

was shaken and the decrease in absorbance of the resulting solution was monitored at 731 nm after 3 min of reaction, using a Jasco V-530 UV-Vis spectrophotometer. The blank solution consisted of 2.5 mL ABTS stock solution and 0.5 mL distilled water. The radical scavenging capacity was compared with that of Trolox and results are expressed as TEAC value (mmol Trolox/1 ml of extract).

DPPH radical scavenging activity

The DPPH method reported by Brand-Williams and colleagues [Brand-Williams 1995] and modified by Litescu and Radu [2000] was followed to evaluate the antioxidant capacity. Aliquots of sample extracts (0.1 mL) were added to 1 mL of a DPPH solution ($2.5 \cdot 10^{-4}$ M in methanol) and 1.9 mL methanol. The mixture was shaken and the decrease in absorbance of the resulting solution was monitored at 516 nm after 3 min of reaction, using a Jasco V-530 UV-Vis spectrophotometer. The blank solution consisted of 2 mL of methanol and 1 mL of a DPPH stock solution. A fresh DPPH radical stock solution was prepared each day. The scavenging activity was calculated using the following equation:

$$\text{Scavening activity } \% = \left[\frac{A_0 - A_S}{A_0} \right] \cdot 100 \tag{3}$$

where:

A_0 – absorbance of the blank,
A_S – is absorbance of the sample at 516 nm.

Statistic analysis

Data were reported as means ± SD for triplicate determinations. Statistical significance were determined using ANOVA programme (Origin Pro8). Results were considered as significant for p-values lower than 0.05.

RESULTS AND DISCUSSION

So far as plant phenolics constitute one of the major groups of compounds acting as primary antioxidants or free radical terminators, it was reasonable to determine their total amount in the selected plant extracts.

The calibration graph has been drawn in order to determine the content of polyphenols (Folin-Ciocalteu method) and total proteins (Lowry method) from sage and mistletoe biopreparations, by spectrometric methods (Fig. 1, 2).

Protein and total polyphenol content were determined in permeate and retentate after ultrafiltration of extracts. The results are shown in the Table 1.

For the three types of tested membranes: Millipore, PSF and PAN, PAN membrane proves to have the greatest efficiency since it shows the highest permeate flux and the greatest retention degree for bioactive compounds. It may be observed, according to the results, that the retention degree for proteins and polyphenols are close to the values of the Millipore and polysulphone membranes, but the permeate flux for Millipore

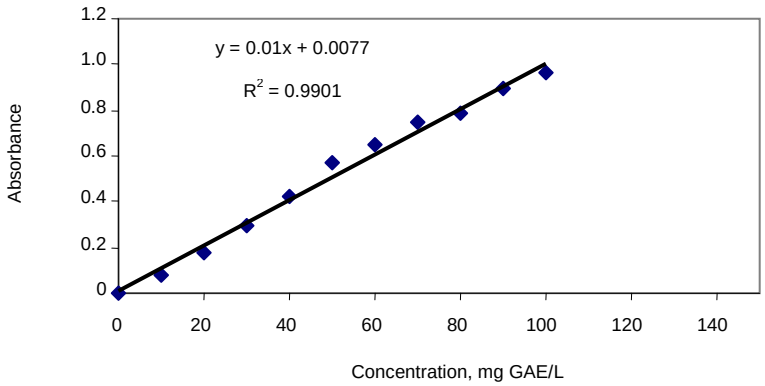

Fig. 1. The calibration graph for the polyphenols quantitative determination at $\lambda = 760$ nm

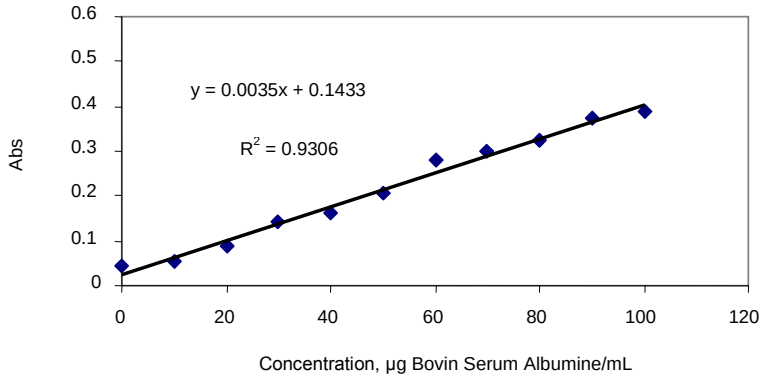

Fig. 2. The calibration graph for the protein quantitative determination at $\lambda = 660$ nm

membrane was higher, though both have similar structures (cut-off 5,000 Da). For PAN membrane the permeate flux (eq. 1) was over 85 L/m^{2}h for all extracts. The degree retention of proteins (eq. 2) from sage extracts was over 71% and from mistletoe extracts was over 80% as they were processed by ultrafiltration, through PAN membrane.

These evidences are valid also for polyphenols from the extracts, but because of it small molecular mass, polyphenols are present in permeate in a great ratio, as well. The degree of retention for polyphenols was up 37.4% as extracts were processed by ultrafiltration, through PAN membrane.

Next step of this research is focused to evaluate the purified and concentrated extracts antioxidant activity. Table 2 shows the antioxidant capacities of the four extracts obtained with the TEAC assay.

Since TEAC is a quantification of the effective antioxidant activity of the extract, a higher TEAC would involve greater antioxidant activity of the samples. Results obtained have shown that highest radical scavenging activity possessed sage hydro-

Table 1. The results obtained on *Salvia officinale* and *Viscum album* L. extracts processed by ultrafiltration, using regenerated cellulose (Millipore), polysulfone (PSF) and polyacrylonitrile (PAN) membrane (pressure: 3 bar)

Sample		Initial	Millipore membrane (UF1)		PSF membrane (UF2)		PAN membrane (UF3)	
			permeate	retentate	permeate	retentate	permeate	retentate
Sage aqueous extract (S1)	Permeate flux L/m^2h	–	72.80 ±3.2	–	68.90 ±3.0	–	88.40 ±5.6	–
	Polyphenols concentration µg GAE/mL	97.02 ±5.6	81.24 ±4.1	120.81 ±8.2	77.63 ±4.5	124.72 ±7.2	72.54 ±4.1	125.81 ±9.7
	Protein concentration mg/mL	1.99 ±0.1	0.94 ±0.0	3.65 ±0.2	0.83 ±0.0	3.98 ±0.3	0.55 ±0.0	4.57 ±0.3
Sage hydro alcoholic extract (S2)	Permeate flux L/m^2h	–	74.90 ±3.4	–	67.40 ±2.8	–	89.1 ±5.0	–
	Polyphenols concentration µg GAE/mL	195.04 ±11.9	167.16 ±9.6	217.34 ±14.5	166.89 ±8.9	219.81 ±16.4	150.50 ±10.3	228.63 ±15.9
	Protein concentration mg/mL	1.96 ±0.1	1.06 ±0.1	3.74 ±0.2	0.89 ±0.0	3.91 ±0.2	0.56 ±0.0	4.07 ±0.3
Viscum album cold aqueous extract (E1)	Permeate flux L/m^2h	–	74.90 ±3.5	–	42.70 ±3.0	–	85.3 ±4.8	–
	Polyphenols concentration µg GAE/mL	119.50 ±9.1	80.84 ±4.0	126.62 ±8.5	79.13 ±4.3	187.43 ±11.5	74.86 ±4.5	198.78 ±12.6
	Protein concentration mg/mL	4.90 ±0.3	1.22 ±0.1	10.84 ±0.7	1.14 ±0.1	11.39 ±0.9	0.97 ±0.0	12.43 ±1.0
Viscum album hot aqueous extract (E2)	Permeate flux L/m^2h	–	77.86 ±4.1	–	55.17 ±3.4	–	96.7 ±6.1	–
	Polyphenols concentration µg GAE/mL	120.11 ±7.4	99.70 ±4.8	151.36 ±11.3	95.03 ±5.2	163.71 ±10.4	87.12 ±5.3	178.09 ±11.8
	Protein concentration mg/mL	5.54 ±0.4	1.28 ±0.1	12.18 ±0.9	1.21 ±0.1	13.54 ±1.0	0.88 ±0.0	14.29 ±1.2

The values are the means ±standard deviation (SD).

-alcoholic concentrated extracts equally, for each ultrafiltration membrane used (356.94; 351.87 and 479.04 µmol Trolox/mL extract) and mistletoe concentrated extracts E2 (345.14; 362.62 and 426.18 µmol Trolox/mL extract). Weaker antiradical activity was evaluated in all permeate extracts.

For both of the sage extracts antiradical activity could be directly correlated to the polyphenols total content, which is about two times greater in retentate than in permeate. This ratio is approximately the same in what concerns the TEAC values. It can be

Table 2. Comparison of Trolox equivalent antioxidant capacity of sage and mistletoe concentrated extracts by ABTS method

Sample			Millipore membrane	PSF membrane	PAN membrane
		TEAC, μmol			
Salvia officinalis aqueous extract	initial extract	183.89 ±7.2			
	retentate		208.43 ±8.2*	209.14 ±7.3*	218.79 ±9.6*
	permeate		108.24 ±4.7	108.10 ±4.9	98.64 ±4.2
Salvia officinalis hydro alcoholic extract	initial extract	322.79 ±12.4			
	retentate		365.94 ±15.7	351.87 ±14.2	479.04 ±19.5
	permeate		160.87 ±6.8	174.31 ±7.2	245.78 ±10.6
Viscum album aqueous extract E1	initial extract	204.02 ±8.1			
	retentate		283.25 ±13.6	300.36 ±13.8	334.42 ±14.1
	permeate		52.72 ±1.9	42.54 ±1.6	29.56 ±0.08
Viscum album aqueous extract E2	initial extract	241.37 ±9.6			
	retentate		345.14 ±15.2	362.62 ±14.1	426.18 ±19.2
	permeate		80.96 ±2.8	59.76 ±2.3	31.25 ±1.4

*Each value in the table was obtained by calculating the average of three experiments ±standard deviation.

observed that the *Viscum album* concentrated extracts have a high antioxidative activity. The obtained results for mistletoe extracts concentration through ultrafiltration (Table 1) show a range of 1.5-2.6 for the polyphenols concentration ratio for the retentate and permeate, depending on the used membrane type. In the same time, data from the Table 2 show the antioxidant activity of the retentate is 13.6 times higher than that of permeate (in case of PAN membrane, for E2 extract of *Viscum*), thus this antioxidant activity increase can't be due only to the polyphenols content. Yet, high antioxidative activity for mistletoe concentrated extracts is provided by the high content of viscolectines (proteic structural compounds) from the *Viscum album* concentrates and in the same way it is also slightly influenced by the polyphenol concentration.

The results were compared with those obtained using Trolox and the TEAC value demonstrates that the concentrated extract is a potent antioxidant.

Ultrafiltration processes offers many advantages over conventional technologies. Its application in phytopharmaceutical industry is particularly interesting since membrane processes can operate at mild temperatures, avoiding damages caused by thermal processes, thus, maintaining the original characteristics of the processed products. Compared with other purification and concentration techniques, including evaporation, and dialysis, ultrafiltration has the capability to process larger volumes at greater speeds and it is a very efficient process. Vacuum evaporation is a slower process and it is feasible with small sample volumes.

The DPPH$^{\bullet}$ method was the second method for the antiradical activity evaluation in case of herbs extracts. DPPH radical scavenging activity represents the free radical reducing activity of the extract based on one electron reduction. The scavenging potential of concentrated extracts was compared with known antioxidants, such as Trolox (Fig. 3, 4).

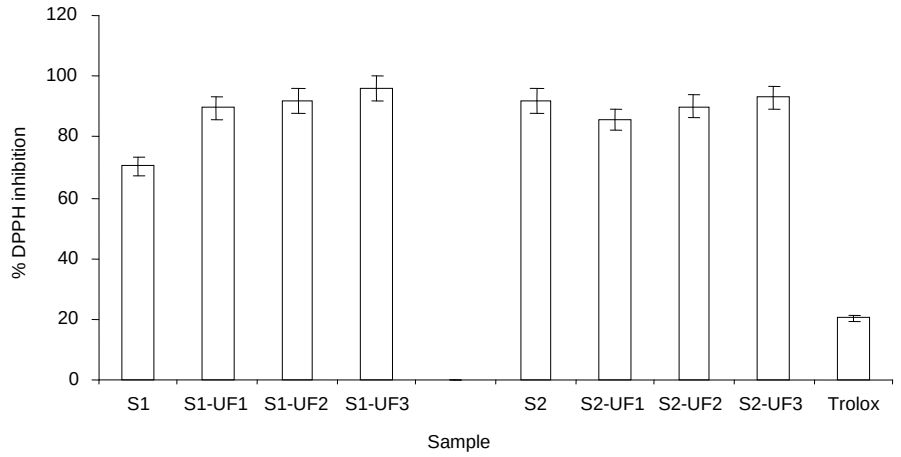

Fig. 3. Comparison of DPPH radical scavenging activity of the concentrated sage extracts and those of Trolox: S1 – aqueous extract from *S. officinalis*, S1-UF1/UF2/UF3 – retentate from ultrafiltration of S1 extract through Millipore/PSF/PAN membrane, S2 – hydro alcoholic extract from *S. officinalis*, S2-UF1/UF2/UF3 – retentate from ultrafiltration of S2 extract through Millipore/PSF/PAN membrane

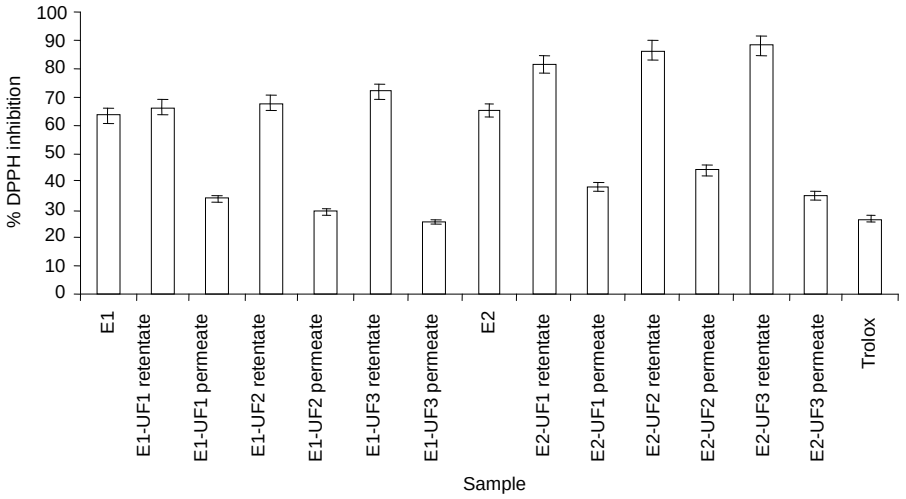

Fig. 4. Comparison of DPPH radical scavenging activity of the concentrated and permeate of mistletoe extracts and those of Trolox: E1 – could aqueous extract from *V. album*, E1-UF1/UF2/UF3-permeate/retentate – permeate/retentate from ultrafiltration of E1 extract through Millipore/PSF/PAN membrane, E2 – hot aqueous extract from *V. album*, E2-UF1/UF2/UF3-permeate/retentate – permeate/retentate from ultrafiltration of E2 extract through Millipore/PSF/PAN membrane

The values obtained by the DPPH assay are over 85% DPPH inhibition for sage concentrated extracts and ranges between 66.2% and 88.2% DPPH inhibition for mistletoe concentrated extracts. The concentrated extracts obtained after ultrafiltration with PAN membrane (UF3) had the strongest scavenging activity for all extracts and almost completely inhibited DPPH absorption (E2 – 88.2%; S1 – 95.7% and S2 – 92.8%).

It can be observed that the content of phenolics in the extracts correlates with their antiradical activity (for *S. officinalis* extracts R between data of DPPH inhibition and total phenolic compounds was 0.99 and for *Viscum* extracts R was 0.87), confirming that phenolic compounds are likely to contribute to the radical scavenging activity of these plant extracts. Meantime, for mistletoe extract the correlation coefficient between data of DPPH inhibition and total proteic compounds was 0.94, confirming that viscolectins have a great contribution to the radical scavenging activity of *Viscum* extracts. A very high scavenging activity against the permeate is observed on the mistletoe concentrated extracts (retentate), and this is in direct connection to the ABTS results.

Extracts are very complex mixtures of many different compounds with antioxidant and pro-oxidant properties, it also depends on the chemical structure of each individual compound present in these extracts. The applied analytical methods show the ultrafiltration process's efficiency by obtaining of *Salvia officinale* and *Viscum album* L. concentrated extracts, with a very high antioxidative activity.

CONCLUSIONS

Two extracts of *Salvia officinale* and *Viscum album* L. were prepared using different solvents and further the two extracts were concentrated by ultrafiltration, using tree types of membranes.

For the three types of tested membranes: Millipore, PSF and PAN, PAN membrane proves to have the greatest efficiency since it shows the highest permeate flux and the greatest retention degree for bioactive compounds. The concentrated extracts obtained after ultrafiltration with PAN membrane had the strongest scavenging activity for all extracts. Results obtained showed that highest radical scavenging activity possessed equally sage hydro-alcoholic concentrated extracts for each ultrafiltration membrane used (356.94; 351.87 and 479.04 μmol Trolox/mL extract) and mistletoe concentrated extract E2 (345.14; 362.62 and 426.18 μmol Trolox/mL extract).

It can be observed that the content of phenolics in the extracts correlates with their antiradical activity (for *Salvia officinalis* extracts R between data of DPPH inhibition and total phenolic compounds was 0.99 and for *Viscum* extracts R was 0.87), confirming that phenolic compounds are likely to contribute to the radical scavenging activity of these plant extracts. Meantime, for mistletoe extract the correlation coefficient between data of DPPH inhibition and total proteic compounds was 0.94, confirming that viscolectins have a great contribution to the radical scavenging activity of *Viscum* extracts. A very high scavenging activity against the permeate is observed on the mistletoe concentrated extracts (retentate), and this is in direct connection to the ABTS results.

The results of this study has revealed that the concentrated extracts have a high antioxidant activity (over 85% DPPH inhibition for sage concentrated extracts and ranges between 66.2% and 88.2% DPPH inhibition for mistletoe concentrated). The concentrated extracts obtained after ultrafiltration with PAN membrane (UF3) had the strong-

est scavenging activity for all extracts and almost completely inhibited DPPH absorption (E2 – 88.2%; S1 – 95.7% and S2 – 92.8%), therefore can be considered as a good source for further medicinal applications.

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AKTYWNOŚĆ PRZECIWUTLENIAJĄCA EKSTRAKTÓW *SALVIA OFFICINALIS* I *VISCUM ALBUM* L. ZAGĘSZCZONYCH Z WYKORYSTANIEM PROCESÓW ULTRAFILTRACJI

Wstęp. Od dłuższego czasu szałwia *Salvia officinalis* L. (*Labiaceae*) i jemioła zwyczajna *Viscum album* L. (*Loranthaceae*) są znane i stosowane jako lekarstwo w medycynie tradycyjnej. W pracy zostały zbadane właściwości przeciwutleniające tych roślin leczniczych. Celem badań było pozyskanie za pomocą procesu ultrafiltracji zagęszczonych ekstraktów i ocena ich aktywności przeciutleniającej.

Materiał i metody. Ekstrakty były przygotowane za pomocą maceracji z wykorzystaniem różnych rozpuszczalników. Po filtracji ekstraktu, poprzez bibułę filtracyjnę Isolab, każdy z filtratów został poddany procesowi mikrofiltracji (MF; Millipore filtr z 45 μm), po uprzedniej ultrafiltracji (UF). W eksperymencie wykorzystano celulozowe (Millipore), polisulfonowe (PSF) i poliakrylonitrylowe (PAN) błony ultrafiltracyjne. W ekstrakcie i przesączu po ultrafiltracji oznaczono białko całkowite i całkowitą zawartość polifenoli. Do oznaczeń właściwości przeciutleniających wykorzystano standardowe metody ABTS i DPPH.

Wyniki. Spośród trzech typów błon ultrafiltracyjnych Millipore, PSF i PAN, membrana PAN wykazywała największą wydajność i najwyższy stopień zatrzymywania komponentów bioaktywnych. Zagęszczone ekstrakty uzyskane po ultrafiltracji z wykorzystaniem poliakrylonitrylowej błony w stosunku do innych ekstraktów miały najsilniejszy stopień zmiatania.

Wnioski. Wyniki badań ujawniły, że zagęszczone ekstrakty mają bardzo wysoki stopień zmiatania rodników (średnia wartość TEAC dla ekstraktu wodno-alkoholowego szałwi 351,87-479,04 μmol Trolox/mL, a dla ekstraktu jemioły 345,14-426,18 μmol Trolox/mL; wartość DPPH była około 85% dla ekstraktu *S. officinalis*, a dla *V. album* pomiędzy 66,2% i 88,2%, dlatego ekstrakty mogą być stosowane w medycynie.

Słowa kluczowe: *Salvia officinalis*, *Viscum album*, ultrafiltracja, aktywność przeciwutleniająca, ABTS, DPPH

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