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Rheological and textural studies of a hydrogel with *Perovskia atriplicifolia* extract

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INTRODUCTION & AIM

P. atriplicifolia Benth. is an ornamental plant with a pleasant and strong scent. It has been used in traditional medicine to prevent and cure various skin diseases.

In this study, the rheological and textural properties of the extract-based hydrogel were characterized. Moreover, the chemical components and antioxidant activity of *P. atriplicifolia* water-ethanol herb extract obtained by ultrasound-assisted extraction (UAE) were analyzed.

METHOD

Experiments were carried out on the aerial parts of *P. atriplicifolia* harvested from the Botanical Garden (Kielce, Poland). Ultrasound-assisted extraction was performed using an extraction solvent (50/50 solution of water and ethanol (*v/v*), 60 mL), which was added to 2 g of dried and powdered plant material. The extraction was conducted twice for 60 min using an ultrasonic bath (Polsonic 5, Warsaw, Poland).

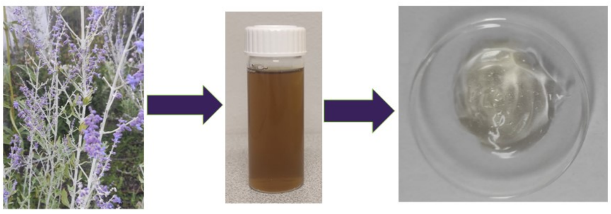

Figure 1. Plant material and plant-based hydrogel.

The spectrophotometric (UV-1900i UV-VIS spectrophotometer, Shimadzu, Japan) and HPLC (Hitachi Chromaster (Esprimo P240, Fujitsu) methods were used to determine the main phytochemical components and the antioxidant activity (FRAP, DPPH) of *P. atriplicifolia* herb extract [1,2]. The hydrogel was prepared based on Carbopol® UltrezTM 10 (Lubrizol, Cleveland, USA). The rheological properties of the extract-based hydrogel were determined using a rotational rheometry method in a plate-to-plate arrangement at 25 °C. Hydrogel was also analysed using a TX-700 texture analyser, in the Compression/Relaxation/Tension (CRT) and Texture Profile Analysis (TPA) modes [3].

RESULTS & DISCUSSION

The antioxidant properties of polyphenolic compounds are related to their chemical structure, particularly the presence of an aromatic ring and the number and position of hydroxyl groups. In the polyphenol-rich water-ethanol *P. atriplicifolia* herb extract, the presence of two phenolic acids (rosmarinic acid and caffeic acid) and one flavonoid (hesperidin) was confirmed, with rosmarinic acid being the dominant compound (Table 1,2). Extract from *P. atriplicifolia* obtained by ultrasound-assisted extraction showed antioxidant potential (Table 3).

Table 1. Phytochemical composition of *P. atriplicifolia*.

Total polyphenols (mg GAE/mL ± SD)	Total flavonoids (mg CE/mL ± SD)	Total phenolic acids (mg CAE/mL ± SD)	Condensed tannins (mg DpE/mL ± SD)
64.46 ± 0.09	17.39 ± 0.06	4.92 ± 0.04	4.12 ± 0.03

Table 2. Polyphenol content of *P. atriplicifolia.*

Compound	Content (mg/mL ± SD)
Caffeic acid	0.04 ± 0.00
Hesperidin	0.16 ± 0.01
Rosmarinic acid	1.32 ± 0.04

Table 3. Antioxidant activity of *P. atriplicifolia.*

DPPH (% ± SD)	FRAP (mmol/L ± SD)
71.89 ± 0.24	1.64 ± 0.01

Texture parameters determine the sensory properties of a product. The results of the CRT and TPA tests showed that the hydrogel had high adhesiveness, supporting effective skin retention and bioadhesiveness. It also exhibited high elasticity, indicating good flexibility in regaining its shape, and cohesiveness above 1, confirming strong structural integrity and good skin adherence (Table 4).

The curves indicated that the preparation exhibited non-linear rheology, characterized by a yield stress. Within the range of shear rates tested, the apparent viscosity decreased, indicating that the formulation behaves as a non-Newtonian fluids diluted by shear (Fig. 2). The results obtained indicate the high sensory quality of the extract-based hydrogel.

Table 4. Texture parameters of extract-based hydrogel (mean ± SD, n = 3, T=25 °C ± 0.1 °C).

Relaxation [%]	Hardness 1 [N]	Hardness 2 [N]	Cohesiveness	Adhesiveness [mJ]	Elasticity
79.9±0.874	0.113±0.016	0.130±0.012	1.445±0.192	0.4±0.1	1.320±0.121

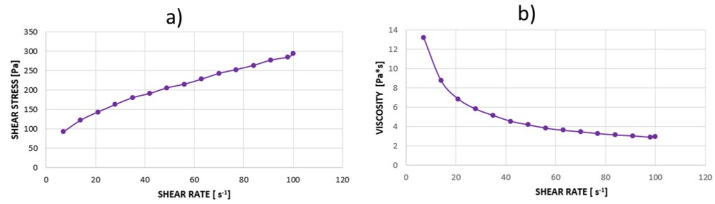

Figure 2. Flow curve (a) and viscosity curve (b) of extract-based hydrogel

CONCLUSION

The composition of the water-ethanol extract of *P. atriplicifolia* is dominated by rosmarinic acid, which is responsible for the properties of this plant, including its antioxidant effect.

A hydrogel based on *P. atriplicifolia* extract containing compounds with antioxidant activity has beneficial rheological and textural properties, ensuring optimal application of the preparation on the skin.

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