PHYSICAL CHEMISTRY 2018

14th International Conference
on Fundamental and Applied Aspects of
Physical Chemistry

Proceedings
Volume II

September 24-28, 2018
Belgrade, Serbia

SBN 978-86-82475-37-8
Title: Physical Chemistry 2018 (Proceedings)
Editors: Željko Čupić and Slobodan Anić
Published by: Society of Physical Chemists of Serbia, Studentski Trg 12-16, 11158, Belgrade, Serbia
Publisher: Society of Physical Chemists of Serbia
For Publisher: S. Anić, President of Society of Physical Chemists of Serbia
Printed by: "Jovan", <Printing and Publishing Company, 200 Copies
Number og pages: 518+4, Format B5, printing finished in September 2018

Text and Layout: "Jovan"

200 - *Copy printing*

PHYSICAL CHEMISTRY 2018

14th International Conference on
Fundamental and Applied Aspects of
Physical Chemistry

Organized by

The Society of Physical Chemists of
Serbia

in co-operation with

Institute of Catalysis Bulgarian Academy of Sciences

and

Boreskov Institute of Catalysis Siberian Branch of
Russian Academy of Sciences

and

University of Belgrade, Serbia:

Faculty of Physical Chemistry
Institute of Chemistry, Technology and Metallurgy
Vinča Institute of Nuclear Sciences
Faculty of Pharmacy
Institute of General and Physical Chemistry, Belgrade, Serbia

Organizing Committee

Chairman:	*S. Anić (Serbia)*
Vice-chairmans:	*M. Gabrovska (Bulgaria)* *A. A. Vedyagin (Russia)* *S. N. Blagojević (Serbia)*

Members: *N. Cvjetičanin (Serbia), S. M. Blagojević (Serbia), M. Daković (Serbia), J. Dimitrić-Marković (Serbia), T. Grozdić (Serbia), Lj. Ignjatović (Serbia), D. Jovanović (Serbia),J. Jovanović (Serbia), M. Kuzmanović (Serbia), D. Marković (Serbia), B. Milosavljević (USA), M. Mojović (Serbia), N. Ostrovski (Serbia), N. Pejić (Serbia), M. Petković (Serbia), A. Popović-Bjelić (Serbia), B. Simonović (Serbia), D. Stanisavljev (Serbia), M. Stanković (Serbia), Z. Šaponjić (Serbia), B. Šljukić (Serbia), G. Tasić (Serbia), S. Veličković (Serbia), N. Vukelić (Serbia)*

Scientific Committee

Chairman:	*Ž. Čupić (Serbia)*
Vice-chairmans:	*V. Bukhtiyarov (Russia)* *S. Todorova (Bulgaria)* *B. Adnađević (Serbia)*

Members: *S. Anić (Serbia), A. Antić-Jovanović (Serbia), D. J. Biswas (India), R. Cervellati (Italy), G. Ćirić-Marjanović (Serbia), V. Dondur (Serbia), S. D. Furrow (USA), A. Goldbeter (Belgium), R. Jerala (Slovenia), M. Jeremić (Serbia), A. Jovović (Serbia), Y. Kalvachev (Bulgaria), E. Kiš (Serbia), Lj. Kolar-Anić (Serbia), U. Kortz (Germany), T. Kowalska (Poljska), V. Kuntić (Serbia), G. Lente (Hungary), Z. Marković (Serbia), S. Mentus (Serbia), K. Novaković (UK), B. Novakovski (Poljska), S. Otto (Netherlands), V. Parmon (Russia), R. Pascal (USA), M. Perić (Serbia), M. Plavšić (Serbia), J. Savović (Serbia), G. Schmitz (Belgium), I. Schreiber (Czech), L. Schreiberova (Czech), H. W. Siesler (Germany), E. M. Barbosa Souto (Portugal), N. Stepanov (Russia), E. Szabó (Slovakia), R. Tomovska (Spain), Á. Tóth (Hungary), M. Trtica (Serbia), V. Vasić (Serbia), D. Veselinović (Serbia), D. Vučković (Canada), V. Vukojević (Sweden), P. Walde (Switzerland)*

Local Executive Committee

Chairman:	*S.N. Blagojević*
Vice-chairmans:	*A. Ivanović-Šašić* *A. Stanojević*

Members: *M. Ajduković, I. N. Bubanja, A. Dobrota, J. Dostanić, D. Dimić, A. Ignjatović, S. Jovanović, Z. Jovanović, A. Jović, N. Jović-Jovičić, D. Lončarević, M. Kragović, J. Krstić, S. Maćešić, J. Maksimović, S. Marinović, V. Marković, D. Milenković, M. Milovanović, T. Mudrinić, B. Nedić, M. Pagnacco, A. Pavićević, N. Potkonjak, D. Ranković, M. Ristić, B. Stanković, K. Stevanović, M. Stević, A. Stoiljković*

BIOACTIVE PULLULAN BASED EDIBLE FILMS WITH MEDICINAL HERBAL EXTRACTS

D. Jakovljević[1], B. Lončarević[1], G. Gojgić-Cvijović[1], A. Žeradjanin[1], N. Lugonja[1], K. Joksimović[3] and V. P. Beškoski[2]

[1]*University of Belgrade, Institute of Chemistry, Technology and Metallurgy, Njegoševa 12, 11000 Belgrade, Serbia (djakovlj@chem.bg.ac.rs)*
[2]*University of Belgrade, Faculty of Chemistry, Studentski trg 12-16, 11000 Belgrade, Serbia.*
[3]*University of Belgrade, Innovation center of the Faculty of Chemistry, 11000 Belgrade, Studentski trg 12-16, Serbia.*

ABSTRACT

In this work, pullulan based films with water extracts of medicinal herbs, thyme and sage, were prepared. Resulting films were characterized by FTIR spectroscopy and their antioxidant properties and antimicrobial activity were evaluated. These products have potential use in food applications, as a supplement to functional food and/or as coatings for food packaging material.

INTRODUCTION

The field of bioactive edible films is in significant development as a result of wide application in food and other industries. In the last decades, the use of some microbial polysaccharides in preparing films greatly increased due to their non-toxicity and biocompatibility [1]. In this context, microbial glycan pullulan has a commercial use for decades as edible film and coating for food applications because this glycan is tasteless and odorless, soluble in water, and impermeable to oxygen [2]. It is widely accepted that pullulan is a linear polysaccharide consisting mainly of 1,6-linked maltotriosyl repeating units that connected mutually by α-(1,6)-glycosidic linkages (Fig. 1.).

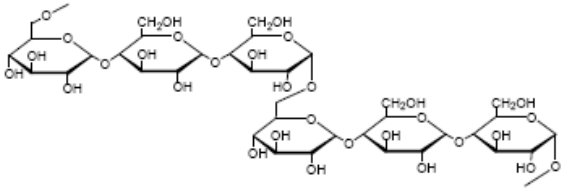

Figure 1. Structure of pullulan

Medicinal plants have traditional and important role in the maintenance of human health. They

are recognizing as source of natural antioxidants and antimicrobial agents due to their biologically active components. In relations to that, the different extracts of medicinal herbs were used for improving functional properties of some polysaccharide based films to find novel promising materials for application in food industry [3].

This paper reports the preparation of pullulan based films containing separately two water extracts of medicinal plant, thyme (*Thymus serpyllum*) and sage (*Salvia officinalis*) as an active ingredients, with aim of obtaining potentially applicable films in food industry as tasty additive or packaging wrap.

EXPERIMENTAL

Pullulan used in this work was produced by the *A. pullulans*, strain CH-1 (IChTM, Collection of Microorganisms) [4]. Medicinal plants *S. officinalis* and *T. serpyllum* were purchased at a local pharmacy. All other reagents and solvents were purchased from commercial sources and used as supplied.

Pullulan powder (3.5 g) was dissolved into distilled water (50 mL) by continuous stirring. Film-forming solutions were prepared with and without addition of two different medical herbal plants, sage and thyme. Water extracts of these plants were prepared separately, by extraction of each plant (6 g) in water (50 mL) with stirring and heating (100 °C, 30 min). After centrifugation (3000 rpm, 20 min), supernatant solutions separately were mixed with aqueous solution of pululan in a ratio of 1: 1 (vol/vol), and poured (per 5 mL each) into Petri dishes (9x50 mm). The solutions were dried at 60 °C for 24 h. After that the thin, transparent films were obtained. Characterization of prepared films was performed using FTIR spectroscopy. Antioxidant and antimicrobial activity were also evaluated [5].

RESULTS AND DISCUSSION

The FTIR spectra of the films containing aqueous extracts shows some significant changes in the peak intensity in the range of 900–1600 cm^{-1} related to pure pullulan. Water extracts of sage and thyme have similar FT-IR profil due to their polyphenolic compounds which are often found in glycosidic form [**6**]. FT-IR spectrum of pullulan (Fig. 2.) shows characteristic absorption bands typical for glycans [7]. However the intensity of the peaks at 1600, 1412, 1280, and 1020 cm^{-1} in the spectrum of pullulan raises after adding the water extracts of thyme (Fig. 3.) and sage (Fig. 4.). This is attributed to the presence of extract compounds which show sharp peaks at the same wavelengths in the FTIR spectrum. These peaks can be assigned as follow: aromatic ring vibrations at 1400–1600 cm^{-1}, OH groups of phenolic

compounds at 1410-1310 cm^{-1}, C–O–C vibrations of esters at 1280 cm^{-1}, C–OH stretching vibrations of secondary cyclic alcohols at 1070 cm^{-1}.

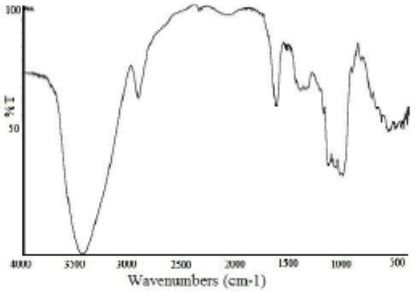

Figure 2. FT-IR spectrum of pullulan

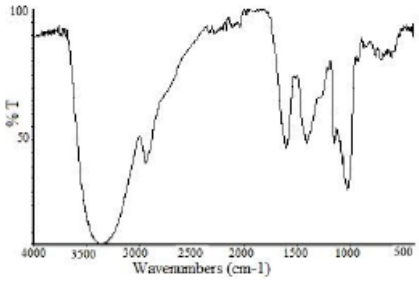

Figure 3. FT-IR spectrum of pullulan-thyme film

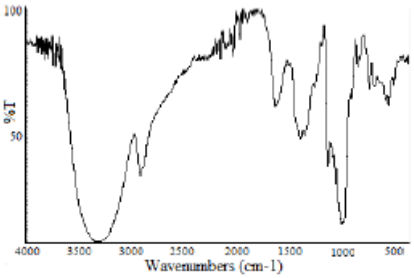

Figure 4. FT-IR spectrum of pullulan-sage film

Antioxidant capacity of prepared films was evaluated *in vitro* by two analytical assays: 1) DPPH (2, 2-diphenyl-1-picrylhydrazyl) free radical-scavenging capability and 2) the chelating ability on ferrous ions. With regard to scavenging ability on DPPH radicals, the samples of film pullulan-thyme and pullulan-sage showed scavenging ability as evidenced by their EC_{50} values were 0.11 and 0.14 mg/mL, respectively. For chelating ability on ferrous ions of these films EC_{50} values were found of 0.33, and 0.25 mg/mL, respectively. Films of native pullulan did not show any anti-oxidant activity.

Antimicrobial effectiveness of films. The antibacterial activity of the formed films was determined by test against *Staphylococcus aureus* ATCC 25923 and *Bacillus subtilis* ATCC 6633. Disks (10 mm diameter) cut from the films were placed on the nutrient agar plates previously surface spread

with inoculums of tested bacteria. After 24-hour incubation at 37 °C, the zones of inhibition of bacterial growth were observed on both samples of prepared film containing plant extracts, while film of pure pullulan did not showed antimicrobial activity.

CONCLUSION

Pullulan based films containing aqueous extracts of medicinal plants thymus and sage were characterized by FT-IR spectroscopic data. Prepared samples showed antioxidant and antimicrobial activities which recommends these films as a promising candidate in food industry.

Acknowledgement

This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia through Project III 43004.

REFERENCES

[1] T. Bourtoom, International Food Res. J., 2008, **15**, 237-248.
[2] K. Cheng, A. Demirci, J.M. Catchmark, Appl. Microbiol. Biotechnol., 2011, **92**, 29–44.
[3] V. Coma, Polímeros, 2013, **23**, 287-297.
[4] D. M. Jakovljević, M. M. Vrvić, M. Đ. Radulović, M. S. Hranisavljević - Jakovljević, J. Serb. Chem. Soc., 2001, **66**, 377-383.
[5] M.N. Alam, N.J. Bristi, M. Rafiquzzaman, Saudi Pharm.J., 2013, **21**,143-152.
[6] G. Gudi, A. Krähmer, H. Krüger, H. Schulz, J. Agric. Food. Chem., 2015, **63**, 8743−8750.
[7] M. Mathlouthi, J.L. Koenig, Adv. Carb. Chem. Biochem., 1986, **44**, 7-89.