PHYSICAL CHEMISTRY 2018

6th Workshop

SPECIFIC METHODS FOR FOOD SAFETY AND QUALITY

September 27th 2018, Vinča Institute of Nuclear Sciences, Belgrade, Serbia

PROCEEDINGS

6th WORKSHOP: SPECIFIC METHODS FOR FOOD SAFETY AND QUALITY

September 27th, 2018, Belgrade, Serbia

is a satellite event of

PHYSICAL CHEMISTRY 2018

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

Organized by

VINČA INSTITUTE OF NUCLEAR SCIENCES
Vinča – Belgrade, Serbia

in co-operation with

THE SOCIETY OF PHYSICAL CHEMISTS OF SERBIA

and

FACULTY OF PHYSICAL CHEMISTRY
UNIVERSITY OF BELGRADE, SERBIA

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Publisher
VINČA INSTITUTE OF NUCLEAR SCIENCES
Vinča - Belgrade, Serbia

Editor
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Design
Milica Ševkušić

Printed by
Skripta Internacional, Beograd

Print run
70 copies

ISBN
978-86-7306-148-1

BELGRADE, SERBIA 2018

P A5

LEVAN AND LEVAN/PULLULAN BLEND FILMS: AFM AND FTIR SPECTROSCOPY CHARACTERIZATION

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ABSTRACT

The numerous naturally occurring biopolymeric materials are used as edible films and coatings (lipids, proteins, and polysaccharides). Microbial levan and pullulan have been already considered as biopolymers in food industry. The aim of this work was to obtain the levan and levan/pullulan blend films and compare them using the Atomic force microscopy (AFM) and Fourier transform infrared spectroscopy (FTIR). Two different films compositions were prepared by casting method: levan and levan/pullulan in the proportions 1:1. AFM measurements showed that levan film had a smoother surface and, consequently, a lower degree of roughness comparing to the levan/pullulan blend films. FTIR spectra showed peaks, which corresponded to all components of the obtained films.

INTRODUCTION

Food packaging is an important discipline in the area of food technology and concerns a preservation and protection of all types of food; however, an increased use of synthetic packaging films has led to the serious ecological problem due to their lack of biodegradability [1].

Biodegradable packaging films are generally prepared by wet casting in an aqueous solution of suitable base material, and later drying. The choice of the base material is important for obtaining films that can improve the gas and moisture barriers, mechanical properties, convenience, microbial protection, and prolong shelf life of various food products. This is in line with the new market needs and evolution of traditional food packaging into the so-called active packaging, which represents the latest trend in the food packaging technology [2]. The numerous naturally occurring biopolymeric

materials are used as edible films and coatings: lipids (waxes, free fatty acids), proteins (gelatin, casein, whey) and polysaccharides (starch, cellulose, chitosan, pullulan) [1,3].

Polysaccharides are known for their structural complexity and functional diversity and their films are known to be an effective barrier to the gas transference although these materials are generally very hydrophilic [3].

Microbial levan has been considered as a biopolymer in food industry due to its biocompatibility, renewability, high molecular weight, low viscous nature, antioxidant and prebiotic effects. Levan is composed of β-(2→6) linked β-D-fructofuranose units with occasional β-(2→1) branching, and carries a D-glucosyl residue at the end of a chain [5].

Pullulan was firstly considered a food additive in food packaging, and then began to be massively used as an edible coating. These coatings were successfully used to extend the shelf life of fresh fruits. The chemical structure of pullulan can be viewed as an α-(1→6) linked maltotriose subunits [6].

The aim of this work was to obtain the levan and levan/pullulan blend films and compare them by Atomic force microscopy (AFM) and Fourier transform infrared spectroscopy (FTIR).

EXPERIMENTAL

The levan used in this work was produced by the *B. licheniformis* NS032 strain [7] and pullulan was commercial Hayashibara Inc. (Okayama, Japan).

Two different film compositions were prepared: levan and levan/pullulan in the proportions 1:1. Films were firstly prepared by making the 15 % polysaccharide(s) suspension in distilled water and then adding the 25 % glycerol as emulsifier (m/m). They were stirred for 15 min, casted onto 50 mm diameter Teflon plates and evaporated at room temperature.

Morphology of the samples was studied by atomic force microscopy with AutoProbe CP-Research SPM (TM Microscopes-Bruker) using 90 μm large area scanner. AFM measurements were performed using noncontact probes Bruker Phosphorous (n) doped silicon Tap300, model MPP-11123-10 with Al reflective coating and symmetric tip. Driving frequency of the cantilever was about 300 kHz. AFM images were taken and later analyzed using the software Image Processing and Data Analysis Version 2.1.15 and SPMLab Analysis, DI SPMLab NT Ver. 6.0.2.

FTIR spectra of levan and levan/pullulan blend films were recorded using a Thermo Nicolet 6700 Spectrophotometer in ATR mode.

RESULTS AND DISCUSSION

Levan isolated from *B. licheniformis* NS032 strain was characterized by elemental analysis, NMR, and FTIR spectroscopy [7]. Obtained levan and levan/pullulan blend films were characterized by AFM and FTIR spectroscopy.

Figure 1 represents the AFM three-dimensional images of the 25 μm surface area of the studied films. They show a smoother surface of levan (1a) film compared to the levan/pullulan blend (1b) films.

Figure 2a shows FTIR spectra of levan film with characteristic peaks for levan type polysaccharides. The peaks at around 3300 cm^{-1}, 2940 cm^{-1} and 1648 cm^{-1} came from the OH stretching vibrations, C-H stretching vibrations and bound water, respectively. Several sharp peaks dominated at around 1000 cm^{-1} due to the C-O-C stretching vibrations, and the presence of furanoid rings was confirmed by peaks at 928 cm^{-1} and 812 cm^{-1} [8,9]. Comparing to the NIST database, the peaks at 865 cm^{-1} and 674 cm^{-1} came from the glycerol.

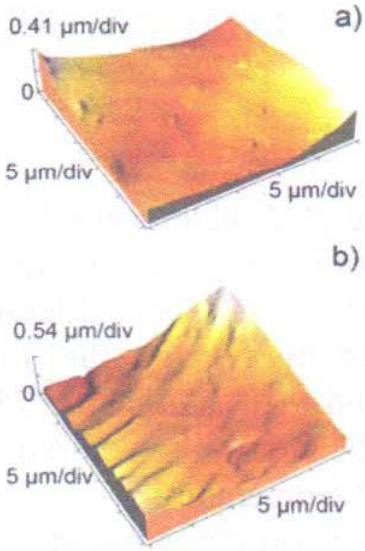

Figure 1. AFM three-dimensional images (surface 25 μm) of (a) levan and (b) levan/pululan blend films.

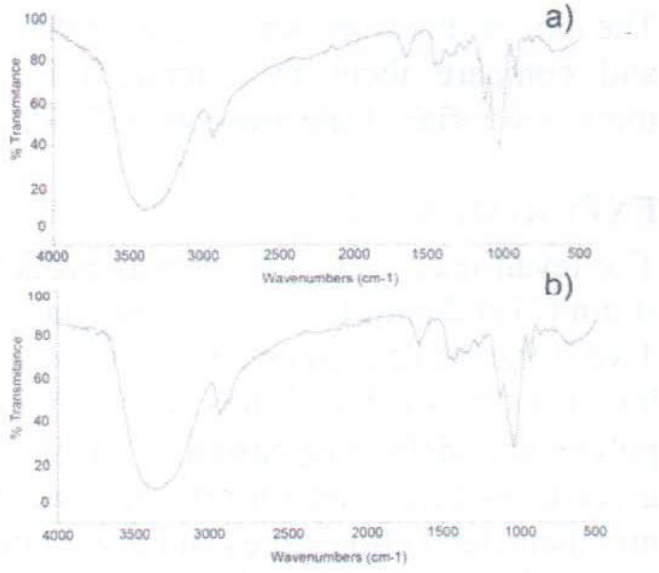

Figure 2. FTIR spectra of (a) levan and (b) levan/pullulan blend films.

FTIR spectrum of levan/pullulan blend film is shown in Figure 2b. The spectrum shows peaks that correlate with a previous spectrum of levan film, which is expected, since it is a mixture of two polysaccharides. A slightly more intense peak at 855 cm^{-1} is characteristic for the α-D-glycosidic linkages present in the pullulan [10].

CONCLUSION

Levan and levan/pullulan blend films were obtained and compared using the AFM and FTIR spectroscopy. FTIR spectra showed peaks, which corresponded to all components of the obtained films while AFM measurements demonstrated that levan film had a smoother surface and lower roughness comparing to the levan/pullulan blend films. However, for in-depth analysis is necessary to investigate the additional parameters by implementing other characterization techniques such as Thermal-gravimetric analysis, Scanning electron microscopy, Tensile strength etc., which will be the subject of further investigations. Obtained films are composed of biodegradable components and therefore are potentially applicable in food industry.

Acknowledgement

This work was supported by the Serbian Ministry of Education, Science and Technological Development within the framework of the Grants III43004 and Project TR32008, and "COST" Action (European Cooperation in Science and Technology) FP1405 "Active and intelligent (fiber-based) packaging—innovation and market introduction".

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