



# Preparation and characterisation of PLA films loaded with *Allium ursinum* L. extract

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COST FP1405

ACTIVE AND INTELLIGENT FIBRE-BASED PACKAGING – INNOVATION AND MARKET INTRODUCTION

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# Poly(lactic acid)-advantages and limitations

Introduction

## ADVANTAGES



## LIMITATIONS

### ➤ Eco-friendly

- ✓ derived from renewable resources
- ✓ Biodegradable, recyclable and compostable
- ✓ Its production consumes carbon dioxide

### ➤ Biocompatibility

- ✓ Non toxic
- ✓ FDA approved

### ➤ Processability

- ✓ Processing-injection molding, blow molding, thermoforming, fiber spinning, and film forming

### ➤ Energy savings

- ✓ PLA requires 25-55% less energy to produce compared to petroleum based polymers

### ➤ Poor toughness

- ✓ Brittle material (less than 10% elongation at break)

- ✓ Limits the use

### ➤ Slow degradation rate

- ✓ PLA degrades through hydrolysis of backbone ester groups

- ✓ Degradation rate depends on crystallinity, molecular weight, molecular weight distribution, morphology

### ➤ Hydrophobicity

### ➤ Gas barrier properties

# *Allium ursinum* L.-WILD GARLIC

Introduction



**CARDIO  
PROTECTIVE**

**ANTIOXIDANT  
ACTIVITY**

**CYTOSTATIC**



**ANTI-  
INFLAMMATORY**

**ANTIDIABETIC**

**ANTIMICROBIAL**

**ANTIPLATELET  
ACTIVITY**

# Aim of this research



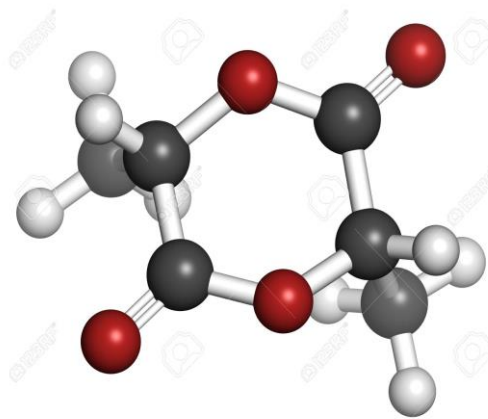
- ✓ Preparation of composite material based on PLA and *Alium ursinum L.* Extract
- ✓ Characterisation of prepared films
- ✓ Possible antimicrobial effect of prepared films



# Materials and methods

M&M

## PLA



$M_w = 171427 \text{ g/mol}$

$M_n = 98530 \text{ g/mol}$

$Q = 1,74$

*Allium*  
*ursinum* L.  
Wild garlic



Dried *A. ursinum* was kindly donated by local tea factory, Fructus doo Bačka Palanka, Serbia.

Before extraction material was grounded in the blender. The particle size of the grounded material (0.325 mm) was determined using sieve sets (Erweka, Germany).

# Sample preparation



Ultrasound-assisted extraction procedure of wild garlic extract

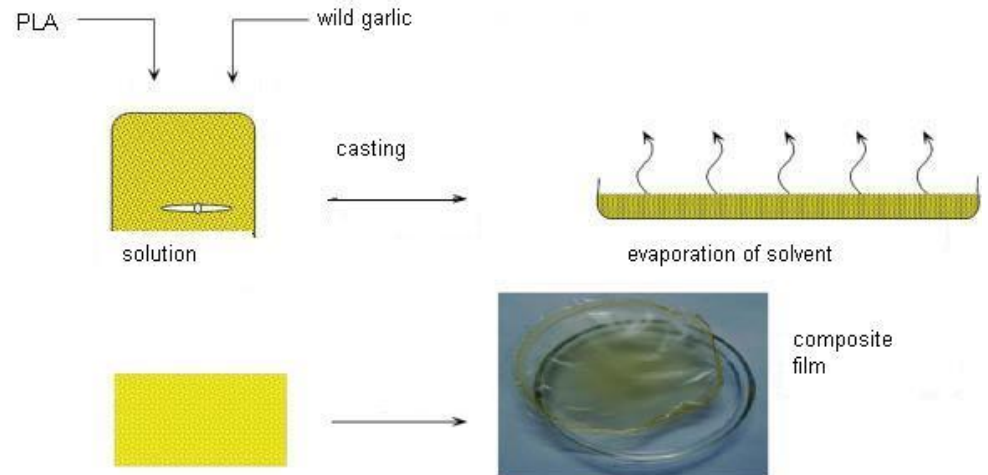
40 kHz



Extraction parameters :

T= 80 °C in 70% ethanol for 79.8 min  
and ultrasonic power of 20.06 W/L  
dried wild garlic/solvent ratio was  
1/5

Solution casting method



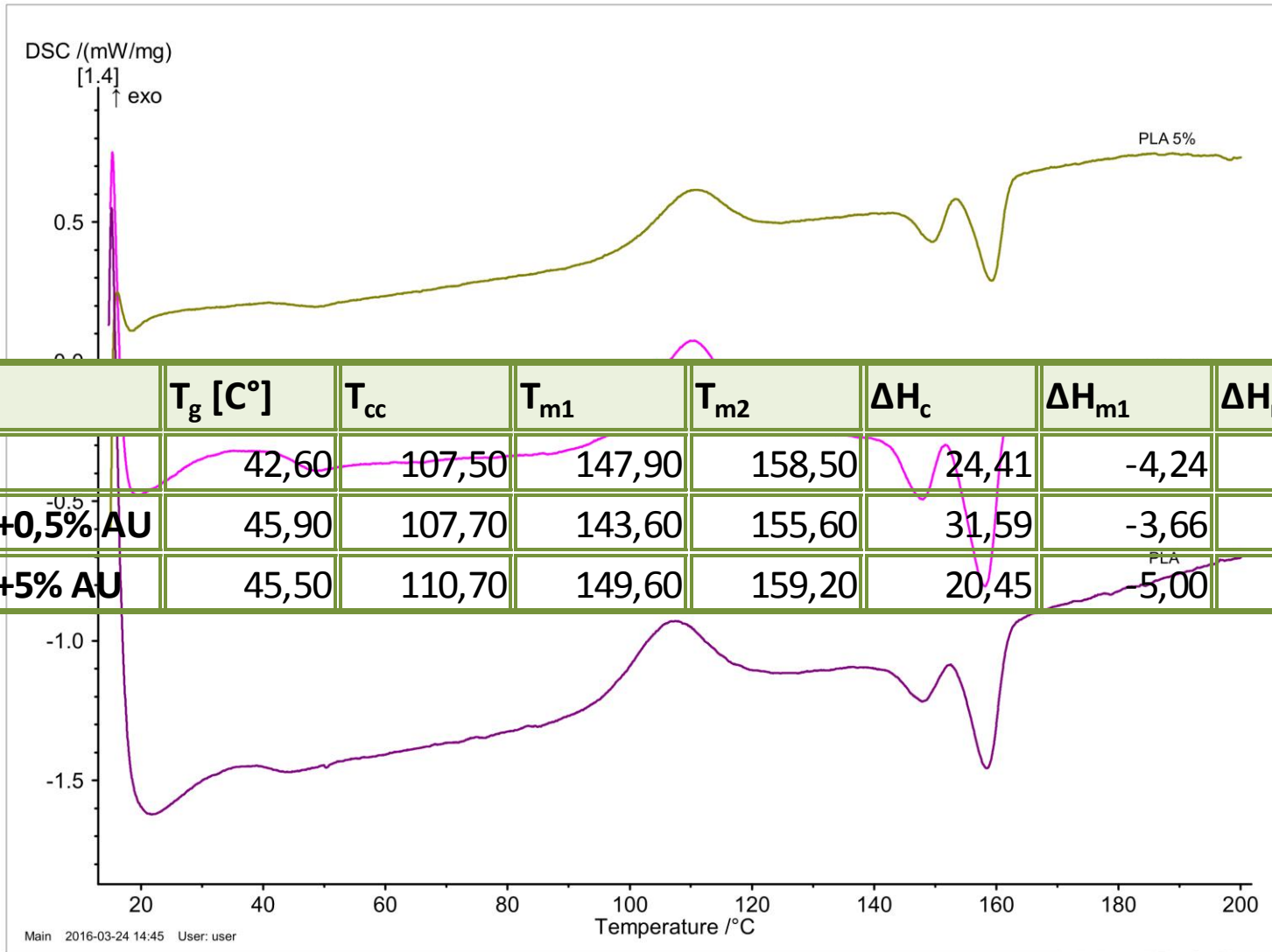
# Characterisation



- Characterisation: thermal, mechanical, optical properties
- Antimicrobial activity of prepared films was tested according to standard test method (ASTM E2149-1) for determination the antimicrobial activity of immobilized antimicrobial agents under dynamic contact conditions. Antimicrobial activity of PLA films (neat and with 0.5 wt. % and 5 wt. % of *A. ursinum* extract) were tested against Gram - negative bacterium *Escherichia coli*.

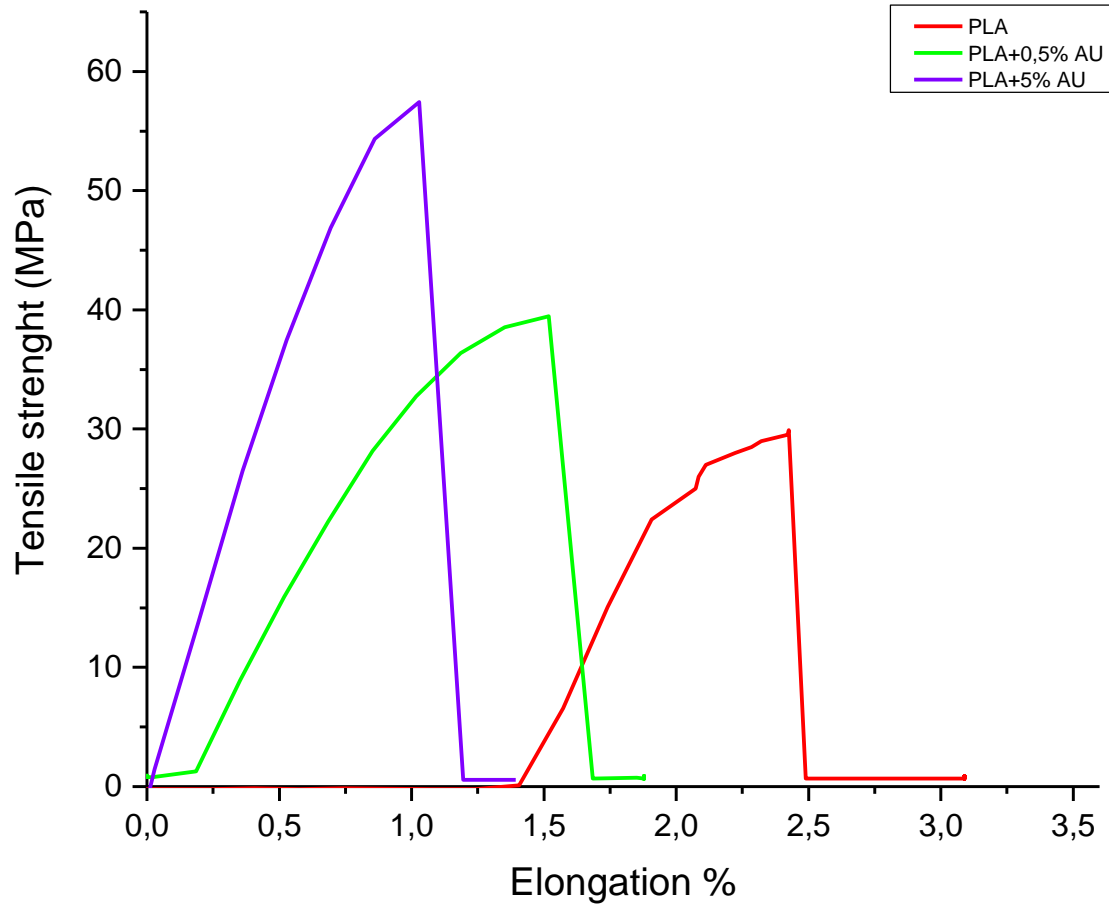


# Thermal properties



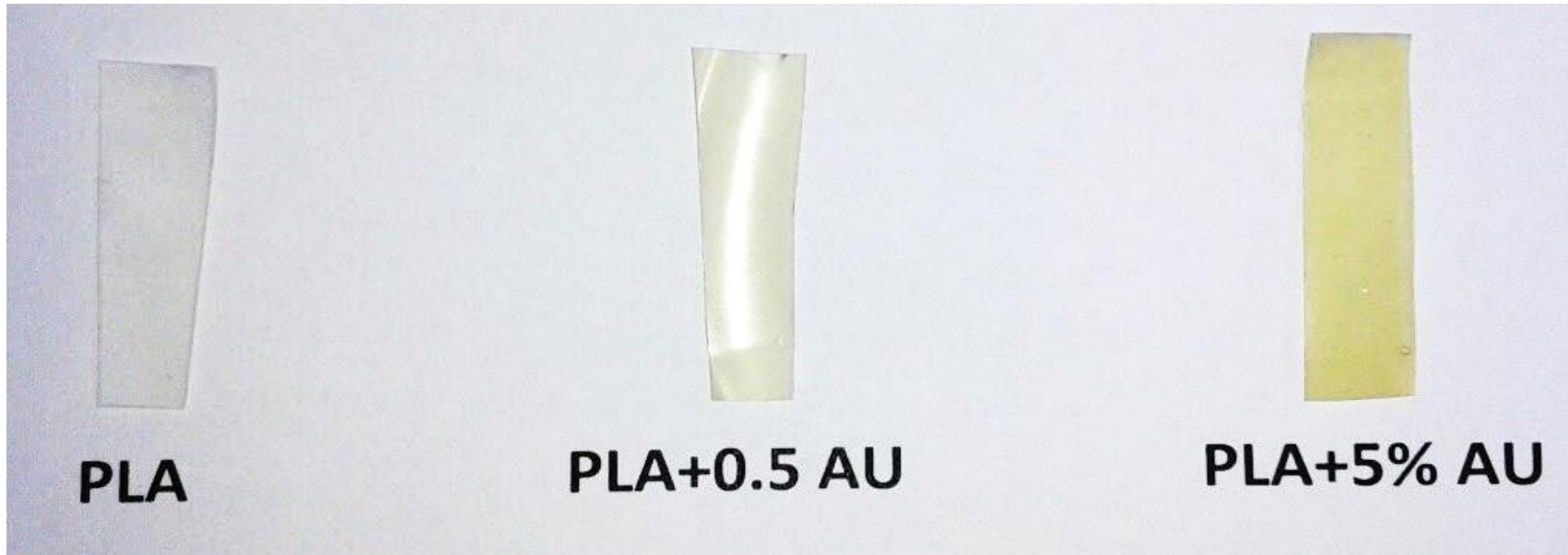


# Mechanical properties



# Optical properties

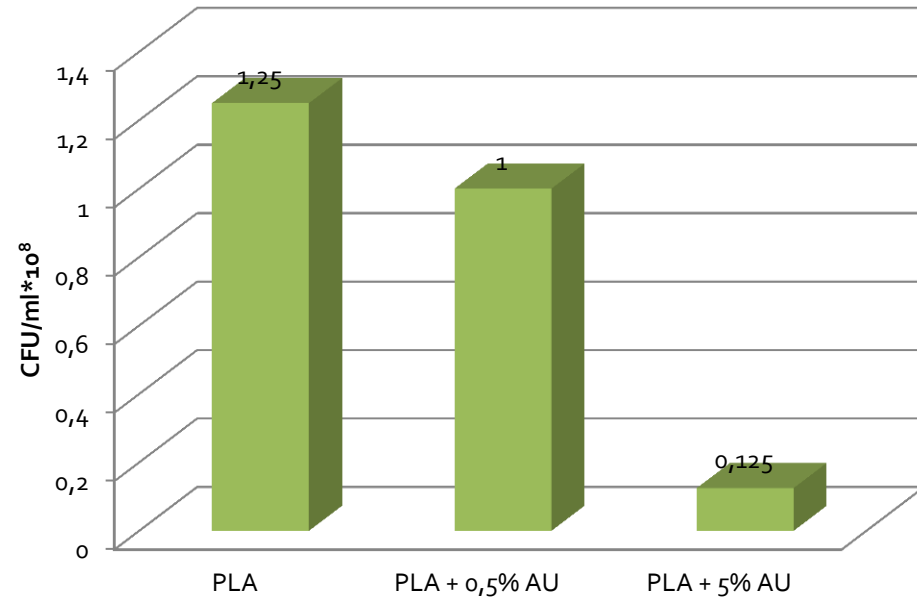
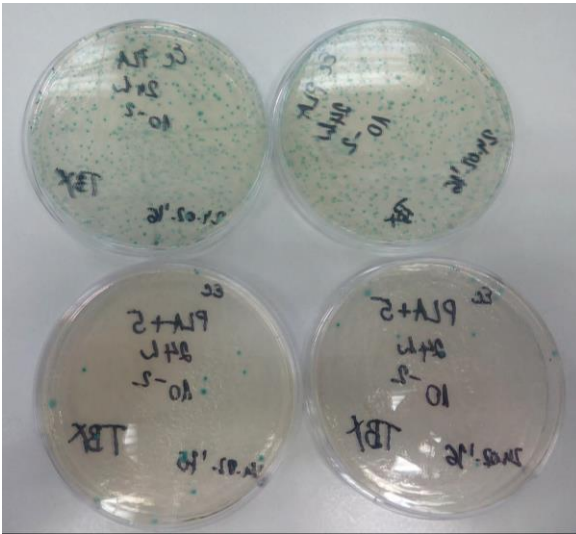
R&D



Uzorak	L*(D65)	a*(D65)	b*(D65)	$\Delta E_{ab}^*$
PLA	91,51 <sup>a</sup>	-0,53 <sup>a</sup>	5,54 <sup>a</sup>	-
PLA-05	91,04 <sup>a</sup>	-1,68 <sup>b</sup>	9,79 <sup>b</sup>	4,42
PLA-5	77,54 <sup>b</sup>	-7,21 <sup>c</sup>	43,92 <sup>c</sup>	41,38

# Antimicrobial potential

R&D



PLA films loaded with 5% AU showed significant reduction of initial *E.coli* after 24h contact time compared to neat PLA films (up to 90%). PLA films with 0,5% AU content didnt show any antimicrobila activity.

# Conclusion



- Addition of two different loadings of *A. ursinum* extract had positive effect on thermal and mechanical properties (increase in  $T_g$  and tensile strength for both loadings).
- Antimicrobial activity of PLA films (neat and with 0.5 wt. % and 5 wt. % of *A. ursinum* extract) were tested against Gram - negative bacterium *Escherichia coli*. PLA films treated for 24h, with 0.5% *A. ursinum* extract showed no reduction in the number of *E.coli* compared to neat PLA films, while PLA films with 5% of extract showed significant reduction (up to 90%) in the number of *E.coli* compared to neat PLA.
- These results are indicating that there is promising potential of incorporation of *A. ursinum* extract in PLA as antimicrobial agent for food packaging applications.

# Thank you for your attention!

**Food and Feed Research**  
congress



**10**  
**FINS**  
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**25<sup>th</sup>-27<sup>th</sup> October 2016.**  
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## Important dates

Deadline for abstract submission  
**15<sup>th</sup> May 2016**  
Abstract acceptance notification  
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Deadline for early registration  
**1<sup>st</sup> July 2016**  
Deadline for full paper submission  
**15<sup>th</sup> August 2016**

REGISTRATION FEE	Before 1 <sup>st</sup> July 2016 (Early registration)	After 1 <sup>st</sup> July 2016 (Late registration)
Full registration fee*	250 EUR	280 EUR
Student's registration fee**	120 EUR	150 EUR
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Dr. Olivera Đuragić  
Congress President



## ACKNOWLEDGEMENT

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