UNIVERSITÀ DEGLI STUDI DI UDINE

5-6 February Zadar, Croatia

Sustainable Network for agrofood loss and waste prevention, management, quantification and valorisation

FoodWaStop COST Action CA22134

Use of by-products for the production of pullulan for postharvest management of strawberries

A. Di Francesco

Postharvest control strategies

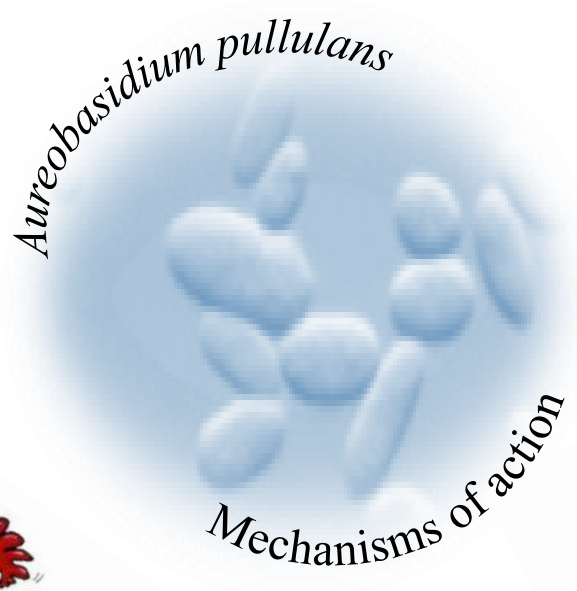
Fungicide treatment NO!!!!

Sanitation practice YES!!!

Alternative approaches YES!!!

- ✓ Pullulan is a tasteless, odorless, non-toxic, non-hygroscopic polysaccharide, and safe for human consumption

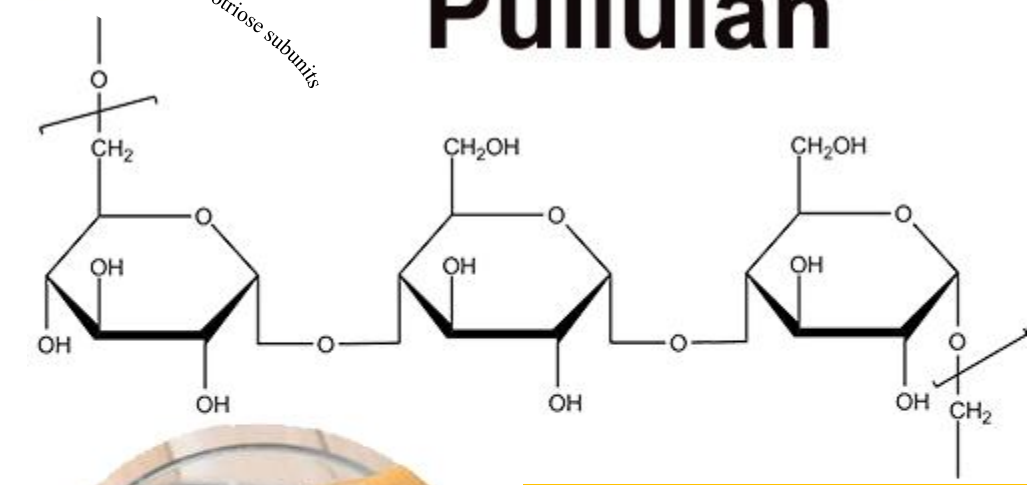
- ✓ Recognized as an ideal substance for application in various food-related sectors by FDA



Mechanisms of action

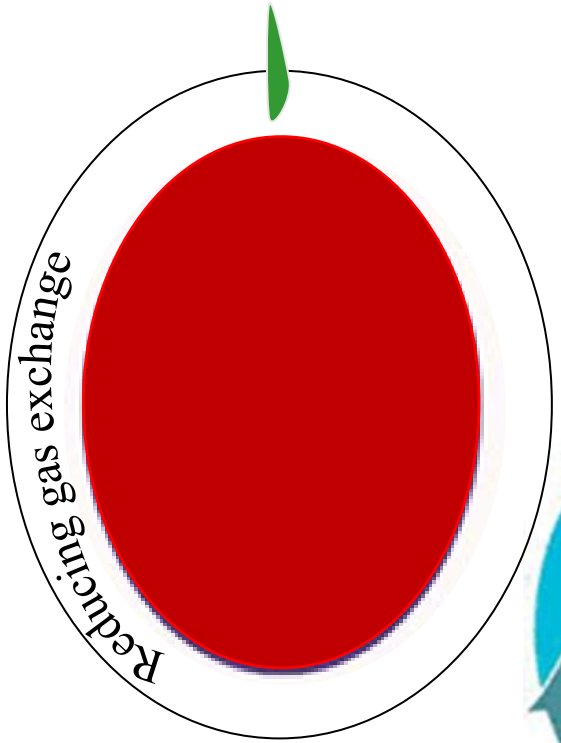
α-(1, 6) and α-(1, 4) maltotriose subunits

Pullulan



- ***Medicine***
- ***Food***
- ***Cosmetics***
- ***Pharmaceuticals***
- ***Biomedical***
- ***Dairy***
- ***Industrial***

Pullulan was suggested to be used as edible coatings of fruits and vegetables



Necrotrophic pathogens - Wound infections
(largely postharvest infections)

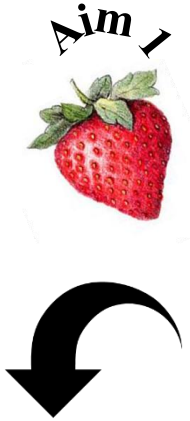
Hemibiotrophic pathogens - direct infections
(largely pre-harvest infections)

One pathogen – one disease symptom

Diseases with multi-species causal agents
mixed infections = "disease complex"

multiple pathogens/organisms – one disease symptom

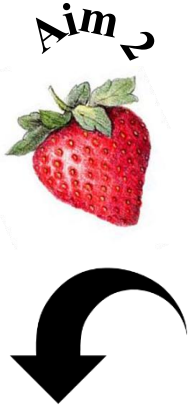
An excellent vehicle for bioactive compounds and BCAs



In vitro

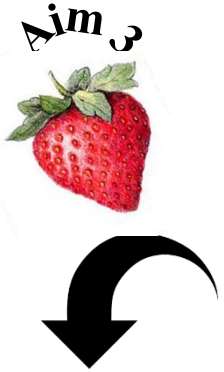
To evaluate pullulan yield produced by *A. pullulans* (AP1) grown on:

- ***Mushroom Basal Bodies (MBB)***
- ***Molasses***
- ***Grape skin***



In vivo

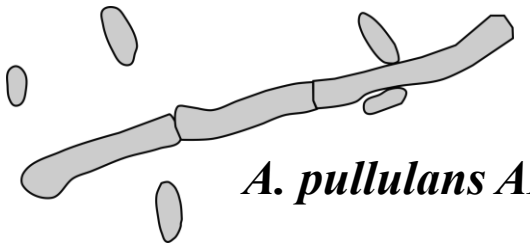
To assess pullulan antifungal activity against *Botrytis cinerea* of strawberries cv ‘Agnese’



Quality parameters

To evaluate pullulan effect on strawberries quality

- Hardness (kg/cm^2)
- pH
- Soluble Solids ($°brix$)
- Weight (g)

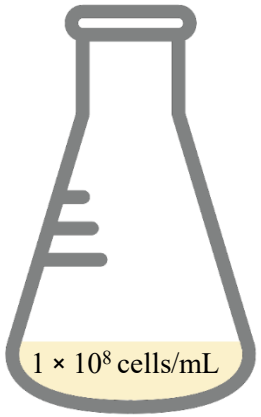


A. pullulans AP1 **strain**

Supernatant was mixed with ethanol (1:2, v:v) overnight at 4 °C

To separate the polymer from the medium

100 mL



EPS Medium

Sucrose 50 g, yeast extract 2 g, KH_2PO_4 5 g, KCl 0,5 g, $MgSO_4 \cdot 7 H_2O$ 0,2 g, and NaCl 1 g per 1 L of DW

Grape skin

Sauvignon Blanc skins (15%) mixed with hot water (60°C), filtered and sterilized

MBB

Pleurotus ostreatus BB (10%) mixed with hot water (60°C), filtered and sterilized

Molasses

Sugar beet Molasses (15%) mixed with hot water (60°C), filtered and sterilized

Flasks incubated at 25°C for 5, 7 and 10 days

Results

in vitro

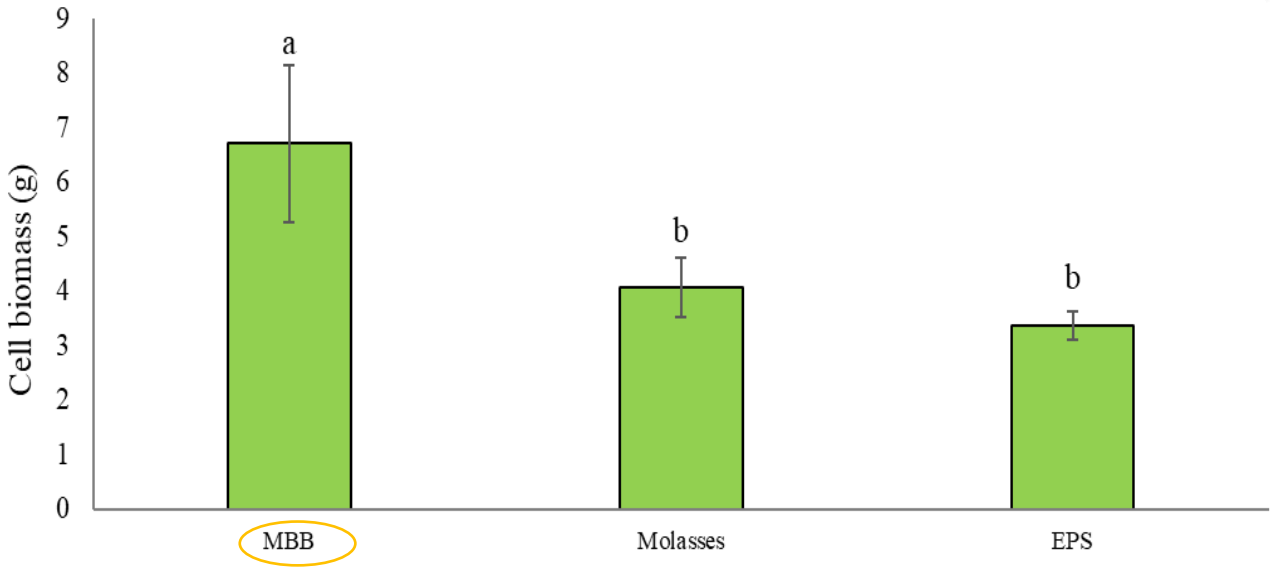
- **Grape skin** by-product inhibited *A. pullulans* AP1 growth

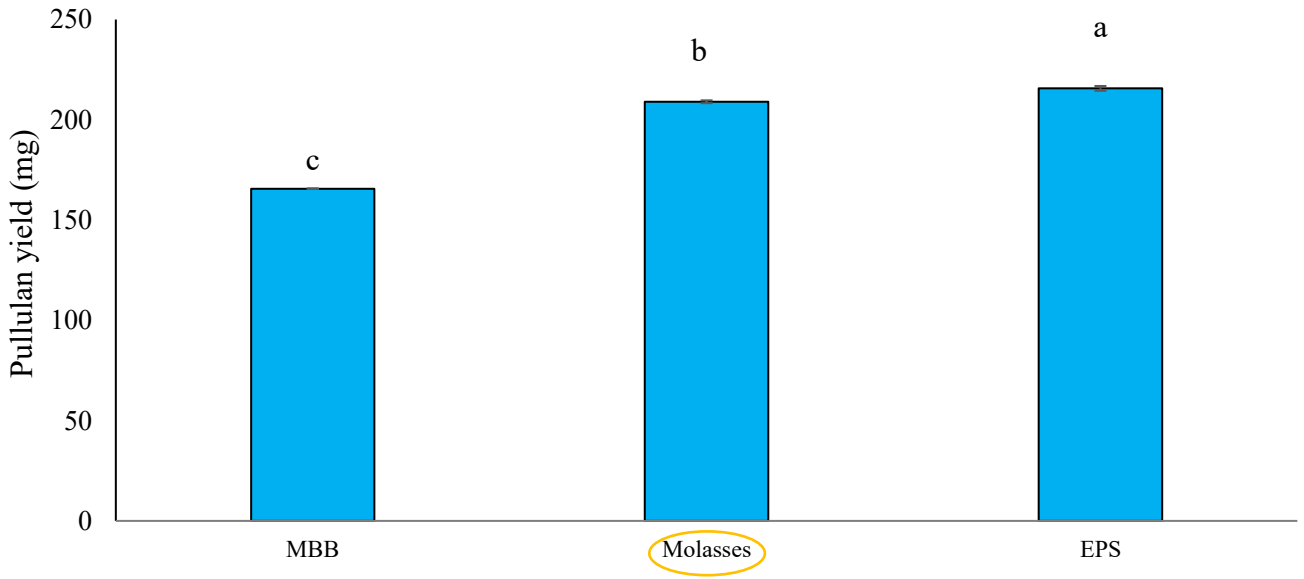
- **Seven days** of fermentation resulted the best time

- **MBB** → Increased yeast cells biomass (g)

- **Molasses** → The most promising by-product **(209 mg/100 mL)**

>52.8%





Quality parameters (pre & post treatment)

Antifungal efficacy

Hardness | pH | Soluble solids | Weight

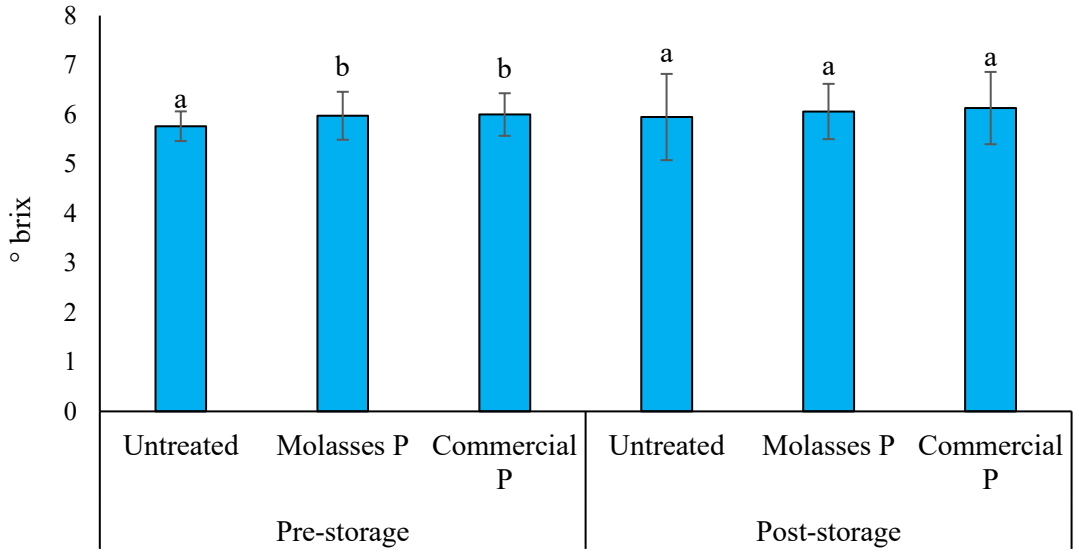
Strawberries *cv* 'Agnese'

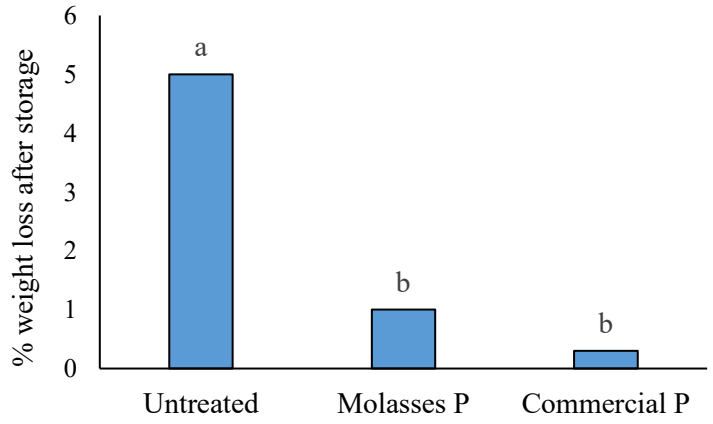
Commercial P | **Molasses P** | **Untreated**

Incubated at 6°C for 5 days

Quality parameters (pre & post treatment)

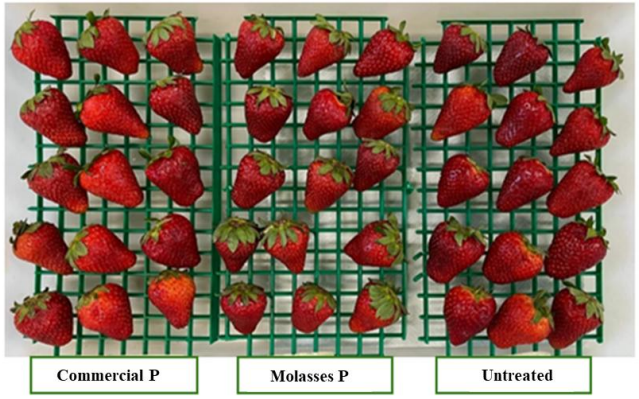
- No differences were detected between pre and post storage for the **pH** (3.5) and **hardness** (1.03 Kg/cm^2)



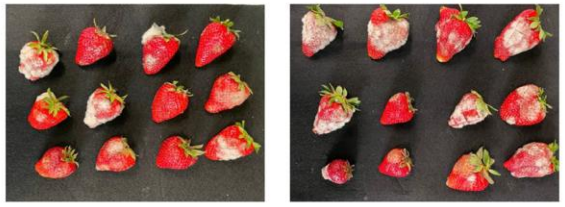


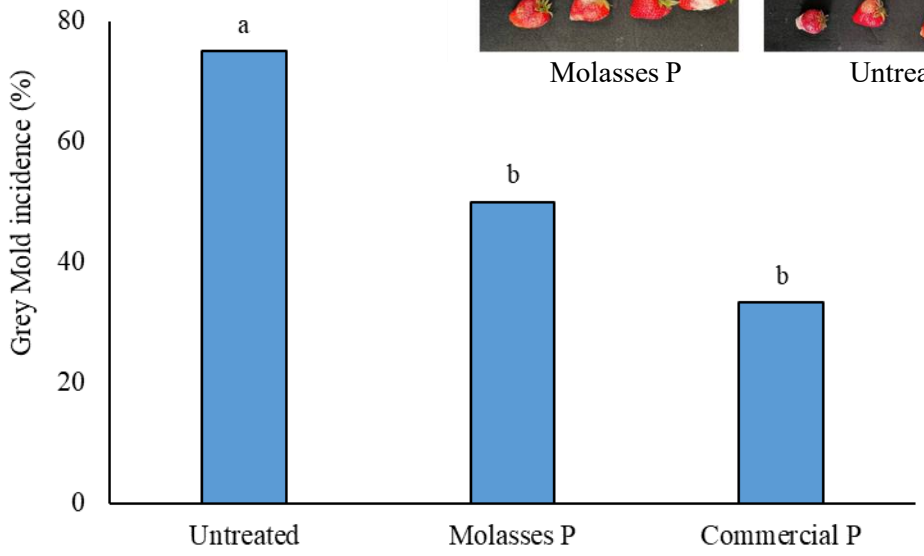
Results

in vivo



-30% with respect to the control





Antifungal efficacy

Synthetic polymers are gradually being replaced by biodegradable compounds as pullulan

Finding **more potential pullulan producer strains** remains the first requirement

✓ **Longer fermentations and medium** are key factors in the synthetic pathway of pullulan

✓ **Coating matrix** can provide:

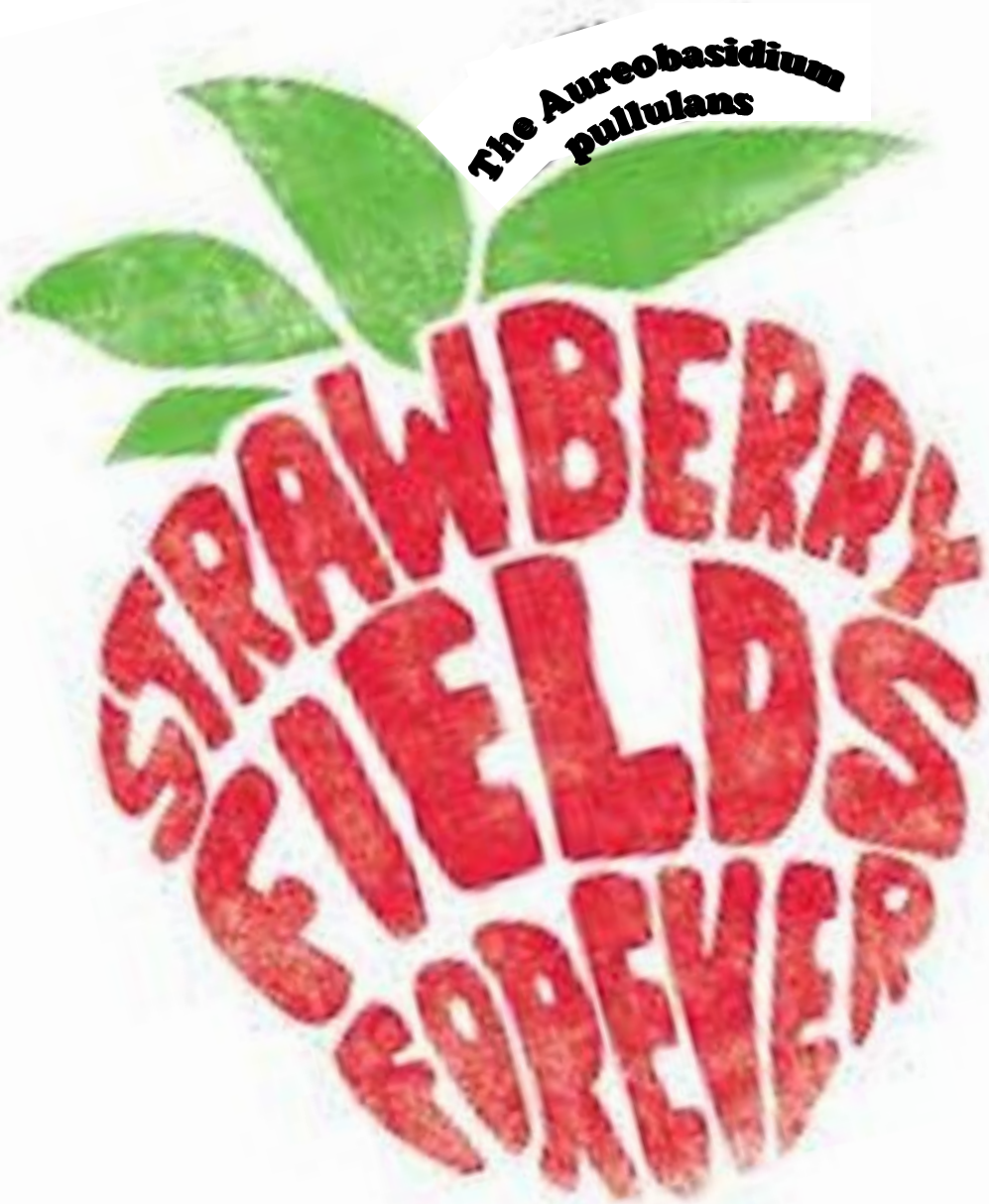
Fruit quality improvement and a higher **Disease Control**

Many factors to consider for developing an active coating such as:

- **viability** and **stability** of the strain
- total **absence of potential food safety hazards**

A significant step forward in food and fruit postharvest management:

Improving the fermentation substrate formula could represent a new frontier to obtain a higher yield of pullulan with optimal chemical composition and optimizing costs



Thanks for your attention!

UNIVERSITÀ DEGLI STUDI DI UDINE
hic sunt futura

FoodWaStop COST Action CA22134

Dr. Rudy Cignola
(Post Doc)

Postharvest Biology and Technology
Volume 230, December 2025, 113779

Exploring the biochemical, technical and applicative characteristics of pullulan produced by different strains of *Aureobasidium pullulans*

R. Cignola [a], L. Palou [b], B. Perez-Gago [b], D. Lovison [a], M. Di Foggia [c], F. Basso [a], E. Daniso [a], L. Garagozzo [d], R. De Marco [a], A. Colautti [a], G. Firrao [a], A. Di Francesco [a]