Valorization of Food By-Products via Solid Submerged Fermentation for Sustainable Mycoprotein Production

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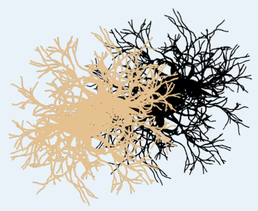
INTRODUCTION

The global population is projected to grow significantly by 2050

Leading to an increasing demand for food and protein worldwide

Alternative sources of protein are needed

Fungal biomass offers an alternative solution to both challenges



- Safe and nutritionally balanced
- Support for new products
- Sustainable
- Low waste demanding

Need for valorization of agro-food by-products

- Environmental damages
- Safety
- Economic losses
- Ethical issues

In the EU, over 58 million tonnes of agro-food by-products (130 kg per capita)

METHODS

By-products Characterization

Brewer's spent grain (BSG)

Cocoa Bean Shell (CBS)

Peanuts Peel (PP)

Banana Peel (BP)

Selection of the most suitable fungal specie for mycoprotein production

Species under study:

Pleurotus ostreatus s1
Pleurotus eryngii
Hericium erinaceus
Pleurotus ostreatus s2
Pleurotus ostreatus black pearl

Mycoprotein (MP)

Fungal Biomass (FB)

Growth in Malt extract Broth (2x) performed in 250 mL Erlenmeyers and 1L Airlift

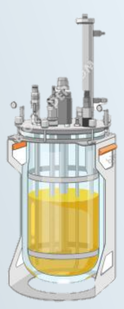
Selection of the most suitable agro-food waste for mycoprotein production

Pleurotus ostreatus

Growth in Malt extract Broth (2x) + 10 % (w/v) of by-product, performed in 250 mL Erlenmeyers

- CBS
- PP
- BP
- **BSG**

Scale up the most promising conditions



3L bioreactor

RESULTS

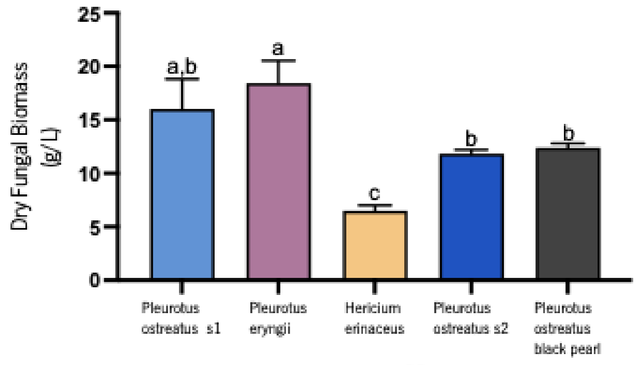
Percentage per Dry Matter (%)

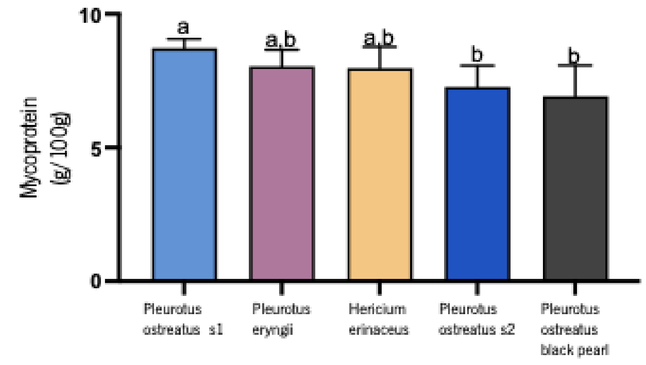
Parameter	BSG	BP	CBS	PL
Moisture	73.0 ± 0.5	86.8 ± 0.4	2.1 ± 0.1	3.4 ± 0.5
Protein	29.2 ± 4.9	6.3 ± 1.0	21.6 ± 1.7	8.8 ± 1.7
Lipids	8.5 ± 1.2	5.1 ± 0.5	8.7 ± 0.4	13.1 ± 1.1
Carbohydrates	1.5 ± 0.2	39.2 ± 1.5	3.7 ± 0.1	7.5 ± 0.3
Total Fiber	52.5 ± 0.8	41.4 ± 4.8	55.7 ± 2.5	67.0 ± 1.0
Ash	3.5 ± 0.1	11.0 ± 0.2	7.7 ± 0.3	2.7 ± 0.1
C:N ratio	**10.8 ± 1.7**	37.9 ± 5.9	**13.6 ± 1.2**	32.5 ± 5.6

For Fungal Biomass and Mycoprotein Production:

- Recommended C:N ratio: 10:1 to 20:1
- Lower ratios (closer to 10:1) favour biomass/mycoprotein synthesis
- High C:N ratio (e.g., >30:1) may limit nitrogen and restrict protein synthesis

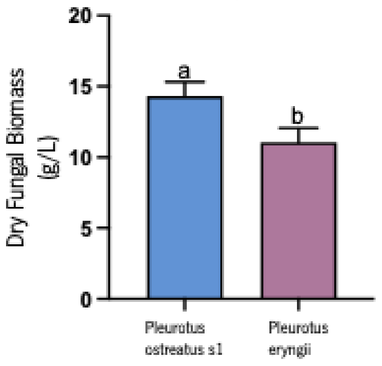
Erlenmeyer 250 mL, 25°C, 200 rpm

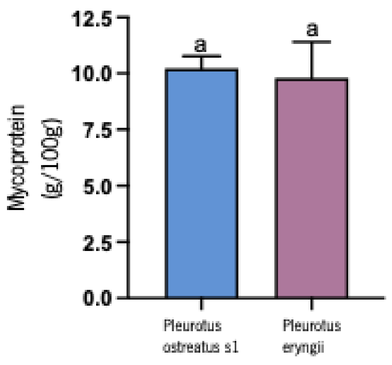




Good relationship between fungal biomass and mycoprotein production

Airlift 1L under constant aeration rate of 6 vvm

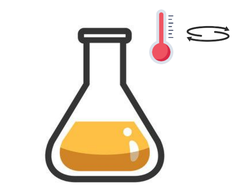




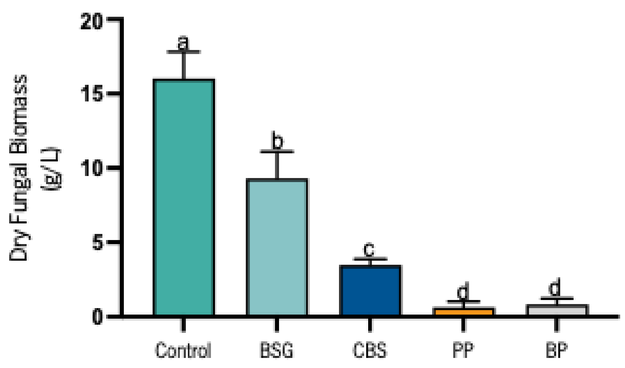
P. ostreatus s1:

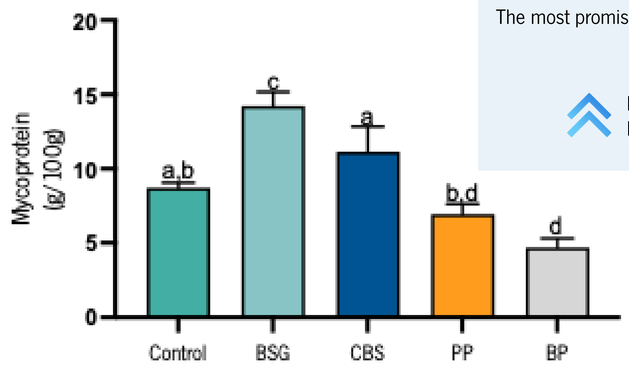
- Higher biomass production
- Similar Mycoprotein production

Higher mycoprotein productivity



Erlenmeyer 250 mL, 25°C, 200 rpm





The most promising agro-food waste:

BSG

Fungal biomass
Mycoprotein

Assessment of the effectiveness of the Scale-up processing using the most promising agro-food waste: **BSG**

25°C, 500 rpm 1 vvm

Dry Biomass:
99.4 g per batch

Mycoprotein:
MP: 15.4 ± 0.95 g/100g

The scale up processing allowed:

Increasing fungal biomass production without compromising mycoprotein content

CONCLUSIONS

- The results emphasize that the intrinsic metabolic characteristics of *Pleurotus* spp. are determinant for biomass and protein accumulation.
- The nutrient balance, particularly the C:N ratio, has a strong influence on substrate utilization by *Pleurotus ostreatus*, thereby affecting both biomass and protein yield.
- Overall, Solid Submerged Fermentation shows greater potential as a bioprocess for valorising agro-food by-products, namely brewer's spent grain (BSG), into mycoprotein.

SCAN ME!

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protein4impact

PROTEIN4IMPACT is an innovative project funded by the Horizon Europe programme, which aims to evaluate the nutritional, health, safety, and environmental impacts of novel protein foods from unconventional sources like agri-food by-products, fungi, bacteria, insects, and (micro and macro) algae. By optimizing production processes and testing feasibility at industrial scales, PROTEIN4IMPACT seeks to enhance sustainable protein alternatives and assess their acceptance in global markets, supporting a healthier, environmentally friendly food future.