28th Workshop on the Developments in the Italian Ph.D research on Food Science, Technology and Biotechnology
Catania, 18-20 September 2024

Bioactive-Rich Mushrooms for Food Reformulation (BIOMUSH-FOOD)

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1. Introduction

The overall objective of this PhD research project is to integrate **bioactive-rich mushrooms** (BRMs), mostly *Basidiomycetes*, grown on agri-food wastes, in different **food formulations** to improve their **nutritional profile**.
The first **activities** of the project included: **A1)** Literature survey about BRMs. The different characteristics of BRMs were studied, focusing on nutritional aspects, bioactive compounds, and cultivation methods and conditions. **A2)** According to the literature survey, mushrooms with the best technological and nutritional characteristics were chosen to study cultivation performances in solid state. BRMs were grown on fresh-cut salad by-products and brewer's spent grain and characterized for growing performances and composition.

2. Materials

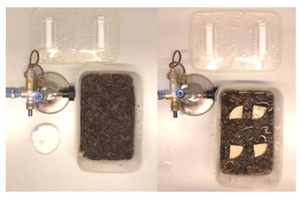
SSF preparation with substrates (MEA-Malt Extract Agar; MS-mix salad by-products; BG-brewer's spent grain)

Sterilization of the substrates (121°C for 25 min)

SSF inoculation of the trays with *P. ostreatus* (ATCC 96997)

For MS and BG addition of an integrating saline solution

SSF incubation at 25°C in the dark, monitoring for 14 days



3. Methods

Growth monitoring	Digital Images	Powershot g7x mark II, Canon
	Thermal Images	Gobi 640, Xenics; active thermography
	FT-NIR spectroscopy	MPA, Bruker optics; fiber optic probe and integrating sphere; 10000-4000 cm^{-1}; 8 cm^{-1} res; 64 scan
Biomass evaluation	Moisture	Gravimetric method [1]
	Protein	Kjeldahl method [1]
	Lipid	Soxhlet method [1]
	Ergosterol	HPLC method [2]

4. Main results

Digital images (Fig. 1) revealed the suitability of the two food wastes as substrates for *Pleurotus* growth. Interesting results were obtained analyzing the thermal images (Fig. 1), because information about biomass thickness can be extrapolated.

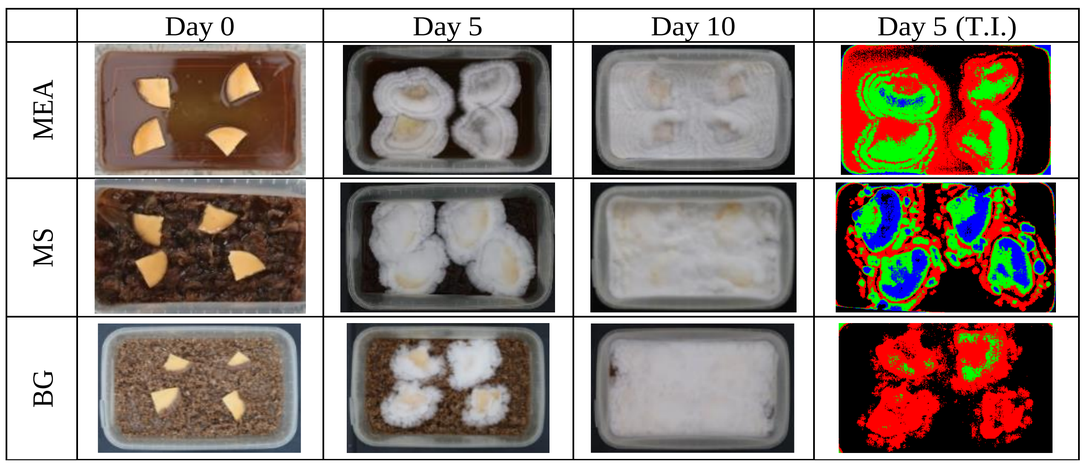


Figure 1: Digital images *of P. ostreatus* during growth on different substrates (MEA, MS, BG) and thermal images (T.I.) where the different colors indicate different temperatures, related to the mycelium thickness.

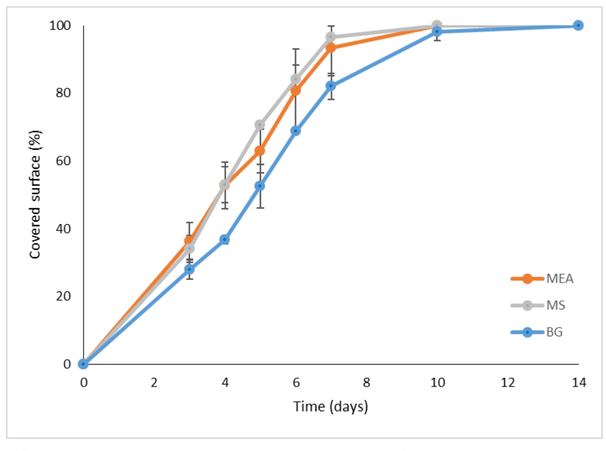


Figure 2: Growth curves of *P. ostreatus* in the different substrates (MEA, reference; MS, fresh-cut salad by-products; BG, brewer's spent grain).

The growth curves were similar for MEA and MS, while BG showed a lower growing rate, even if at the end of the growth the whole surfaces were covered by the mycelium (Fig.2).

PCA of the FT-NIR spectra acquired on the biomass surface by the fiber-optic probe showed an increasing trend until 10 days of the PC2 scores (Fig. 3A). Similar results were obtained with spectra of the homogenized samples collected with the integrating sphere, considering PC1 scores (Fig. 3B), even if less clear than those obtained on the surface.

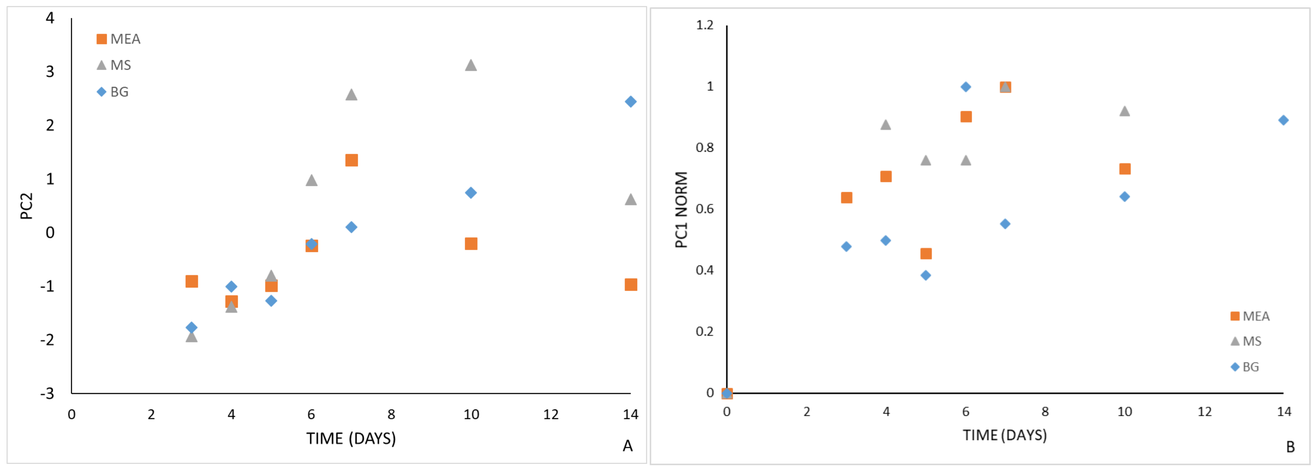


Figure 3*: Results of FT-NIR analysis: PC2 or PC1 scores as a function of growing time. A, spectra collected on the biomass surface; B, spectra collected on the homogenized samples.*

At the end of growing (14 days), the mycelium was harvested and freeze-dried. Table 1 shows the results of the production yield (in d.m.) and compositional characterization of the mycelia grown on the different substrates. The biomass grown on MS showed a good and promising protein content (32.5% d.m.) considering the poorer composition of the substrate (15.3% d.m.).

Table 1: *Results of production yield and composition of the mycelium biomasses after 14 days of growth on the different substrates.*
**Data at day 10*

	Production yield (%)	**Dry matter (%)**	***Protein (% d.m.)***	***Lipid (% d.m.)***	***Ergosterol (ppm d.m.)****
MEA	1.2	8.7	15.8	1.0	952.7
MS	2.1	6.8	32.5	1.0	229.2
BG	5.0	15.9	30.4	5.6	876.0

5. Conclusions

Both the agri-waste used in these experiments proved to be valid substrates for solid state fermentation of *P. ostreatus*. In particular, the use of MS resulted in a higher protein content, thus better valorizing the initial substrate. Considering the technologies used for growth monitoring, all of them showed promising results, thus providing fast procedures for the evaluation of the solid state fermentation.

References

[1] AOAC, 1990. Official methods of Analysis, 14° ed. Association of Official Analytical Chemists, Washington, DC
[2] Pedrali, D., Gallotti, F., Proserpio, C., Pagliarini, E., & Lavelli, V. (2020). Kinetic study of vitamin D2 degradation in mushroom powder to improve its applications in fortified foods. *LWT-Food Sci Technol*, **125**, 109248

Acknowledgments: Funder: Project funded under the National Recovery and Resilience Plan (NRRP), Mission 4 Component 2 Investment 1.3 - Call for tender No. 341 of 15 March 2022 of Italian Ministry of University and Research funded by the European Union – NextGenerationEU; Award Number: Project code PE00000003, Concession Decree No. 1550 of 11 October 2022 adopted by the Italian Ministry of University and Research, CUP D93C22000890001, Project title "ON Foods - Research and innovation network on food and nutrition Sustainability, Safety and Security – Working ON Foods".