IOCFE 2025 Conference
The 1st International Online Conference on Fermentation
12–13 November 2025 | Online

Solid-state fungal fermentation as a sustainable strategy to increase protein and antioxidant capacity in plant-based by-products

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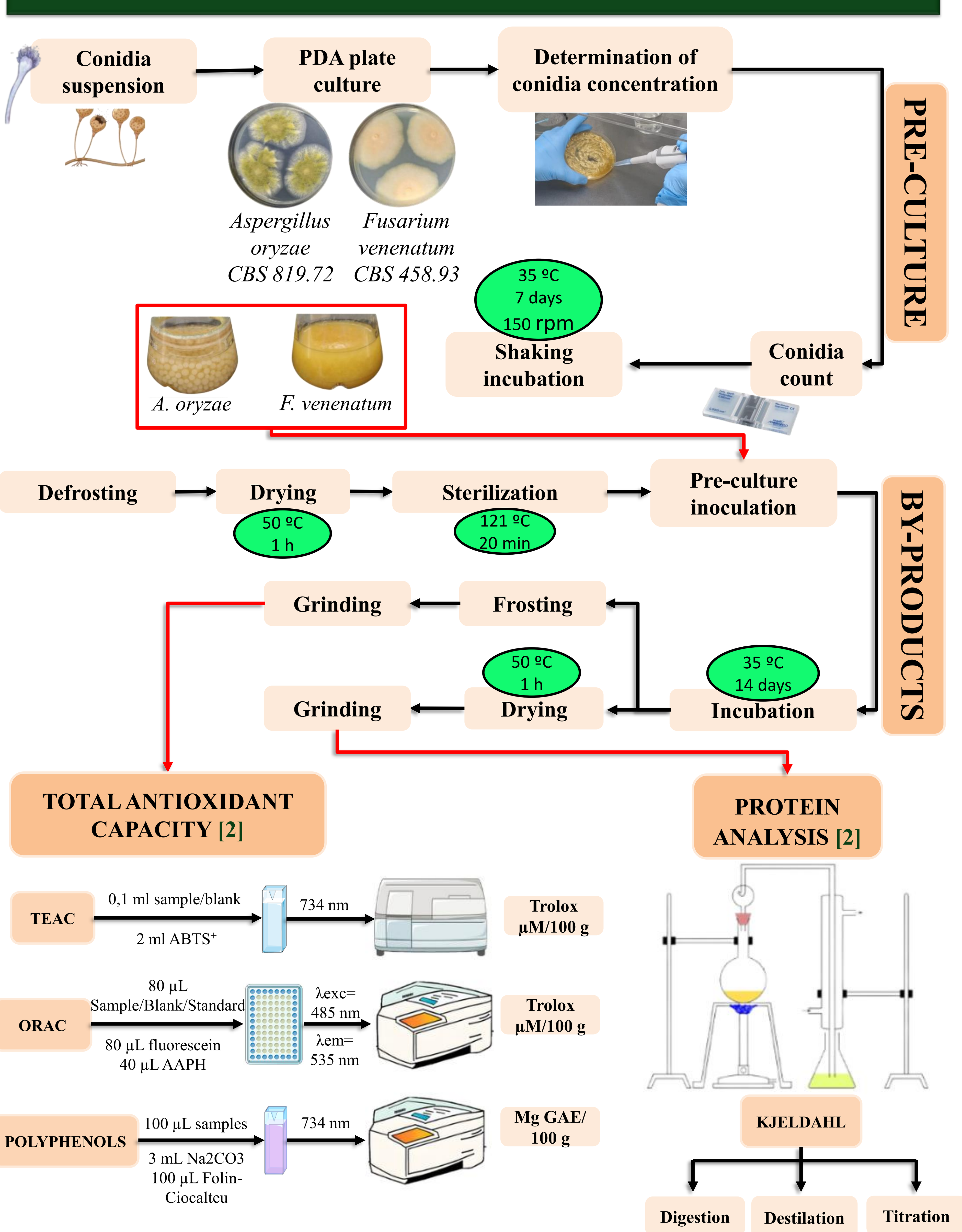
INTRODUCTION & AIM

The increasing need for sustainable food production has driven initiatives to minimize the ecological impact of the food sector. Among the new methods, the valorization of by-products using biotechnological techniques presents a promising way for improving resource efficiency. Solid-state fungal fermentation (SSFF) has attracted interest for its ability to convert agro-industrial waste into valuable products rich in nutrients and bioactive substances [1]. This research investigates the application of SSFF on by-products from plant-based beverages made from local raw materials—tiger nut, carob, and rice [2]—using *Aspergillus oryzae* and *Fusarium venenatum* to obtain ingredients with higher protein content and improved antioxidant properties, contributing to the circular economy and sustainable innovation.

METHOD



RESULTS & DISCUSSION

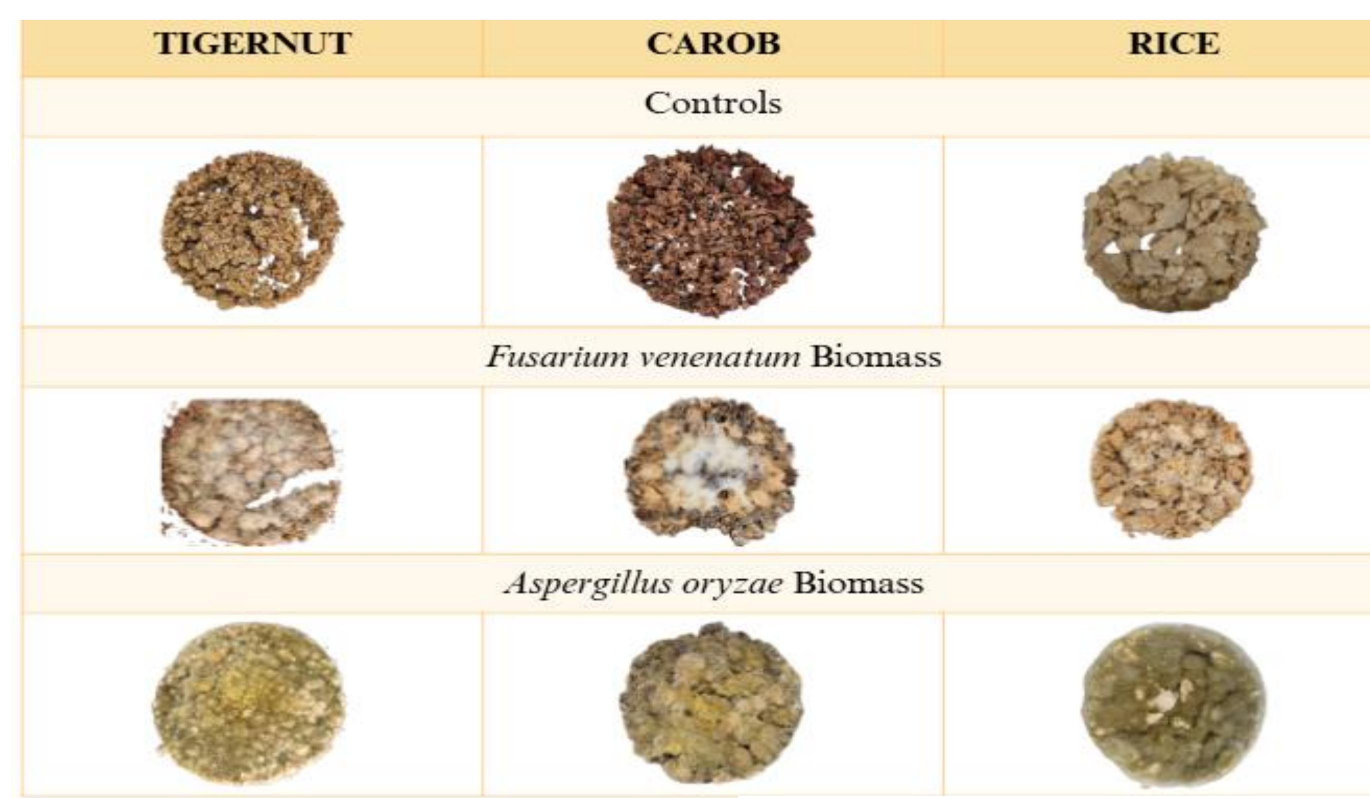


Figure 1: Controls and fungal biomass produced by Fusarium venenatum and Aspergillus oryzae in carob, rice, and tiger nut by-products.

Both fungal species showed colonization capacity in the three by-products studied, although with different patterns. *A. oryzae* showed homogeneous and dense growth in all substrates, while *F. venenatum* showed variations depending on the substrate, with particularly limited development in the rice by-product.

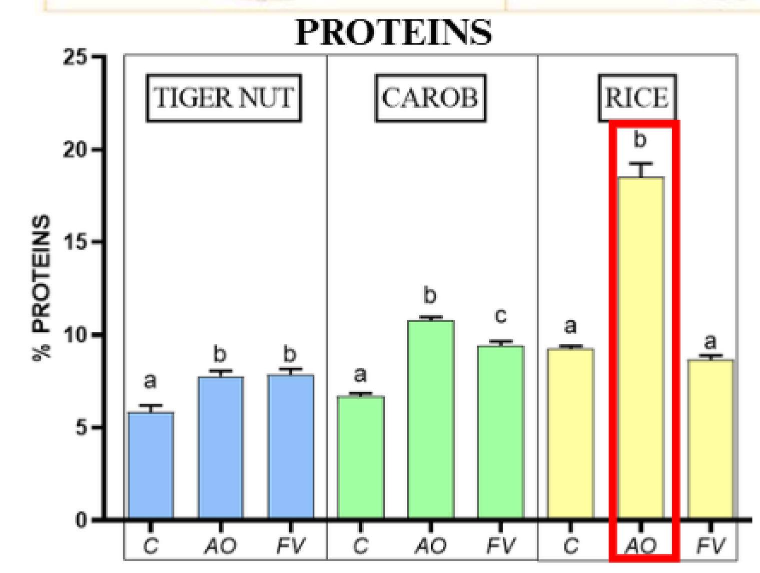


Figure 2: Protein content by the Kjeldahl method from fungal biomass obtained from the by-products of tiger nut, carob, and rice.

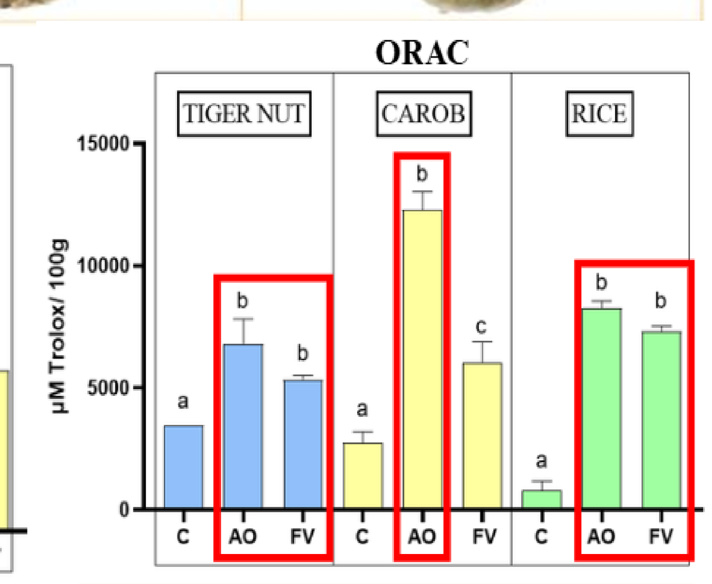


Figure 3: Antioxidant content by the ORAC method from fungal biomass obtained from the by-products of tiger nut, carob, and rice.

C: Control
AO: *Aspergillus oryzae*
FS: *Fusarium venenatum*
Different letters (a-c) indicate statistically significant differences according to the ANOVA-Tukey test with a significance level of 95% (p value < 0.05).

SSFF produced a significant increase in the **protein content** of all substrates evaluated. This increase was greater in *A. oryzae* than in *F. venenatum*, with no significant improvements observed in the rice by-product.

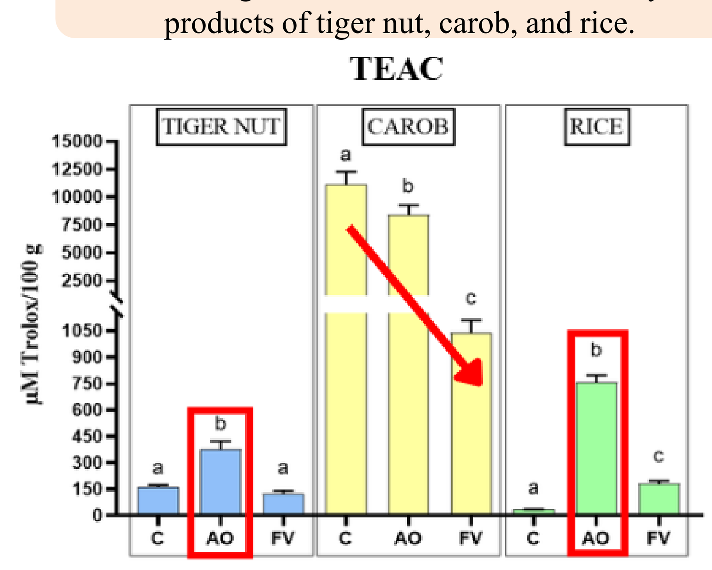


Figure 4: Antioxidant content by the TEAC method from fungal biomass obtained from the by-products of tiger nut, carob, and rice.

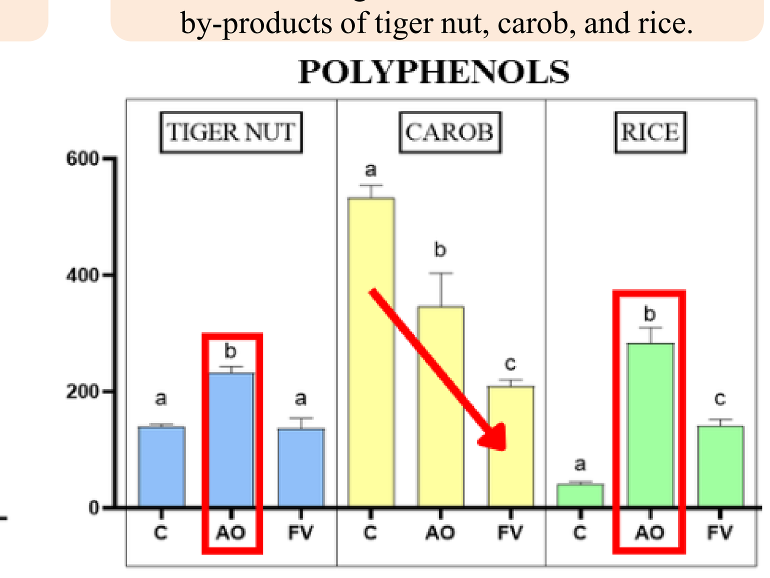


Figure 5: Total polyphenols content by the Folin-Ciocalteu method from fungal biomass obtained from the by-products of tiger nut, carob, and rice.

Analysis of total antioxidant capacity revealed different behaviors depending on the analytical method used, justifying the use of multiple evaluation techniques:
- **ORAC** method showed consistent increases in all fermented substrates, being particularly significant in carob with *A. oryzae*.
- **TEAC** and **Folin-Ciocalteu** methods presented statistically similar results. Carob was found to have the highest initial content of phenolic content,

CONCLUSION

- SSFF with *A. oryzae* produced a significant increase in the protein content, achieving increases of 100% in rice, 61% in carob and 33% in tiger nut compared to the non-fermented controls. *F. venenatum* obtained yields of 41% in carob and 35% in tiger nut, showing no significant improvements in the rice by-product.
- Total antioxidant capacity determined by ORAC method showed consistent increases in all fermented substrates, being particularly significant in carob with *A. oryzae,* while with TEAC method increases were only evident with *A. oryzae* in tiger nut and rice. Carob had the highest initial content of phenolic compounds, although fermentation reduced them, but increases were observed for tiger nut and rice instead.
- The potential of SSFF for the production of mycoprotein from plant products has been demonstrated to be matrix and fungi-dependent, contributing to the development of alternative and sustainable protein sources with increased antioxidant properties.

REFERENCES

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Acknowledgements

This study is part of the AGROALNEXT program (AGROALNEXT/ 2022/047) with the support of the MCIN and funding from the European Union Next Generation EU (PRTR-C17·I1) and the Generalitat Valenciana (Spain). Matteo Vitali has a research staff contract in the afore- mentioned project (CPI-22-735).

Financiado por la Unión Europea NextGenerationEU
Plan de Recuperación, Transformación y Resiliencia
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