

Unlocking the Nutritional Potential of Broccoli Stalks powders obtained via lyophilisation and hot air dehydration

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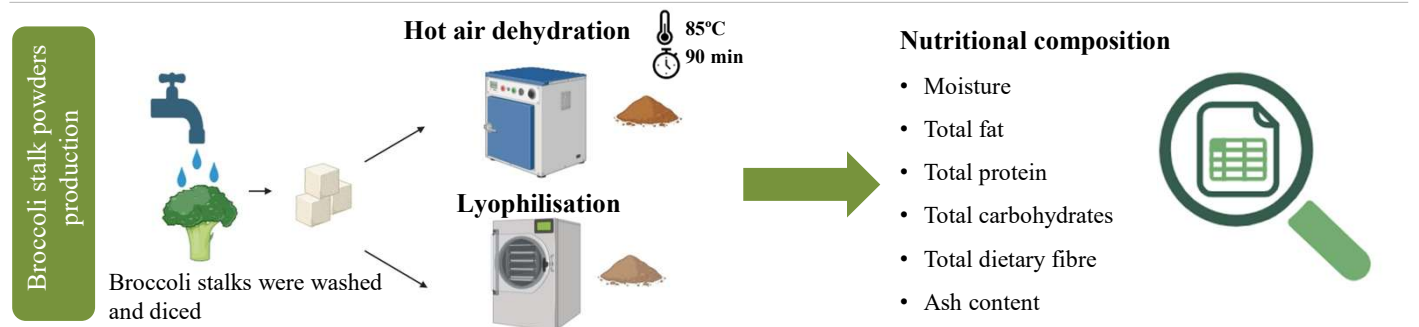
Introduction

The **food industry** is increasingly embracing **sustainable practices** and **circular economy** principles to **reduce environmental impact** and **improve resource efficiency** (Rabbi and Amin, 2024). One promising approach involves the **valorisation of vegetable by-products**, traditionally considered waste, into **value-added ingredients** (Ramírez-Pulido et al., 2021). **Broccoli stalks**, often discarded during processing, represent an underutilised by-product with valuable **nutritional potential** (Wang et al., 2025).

Objectives

Evaluate the **nutritional composition** of **broccoli stalk powders** obtained through two drying techniques: **lyophilisation** and conventional **hot air dehydration**.

Methods



Results

Table 1 – Nutritional composition of broccoli stalk powder obtained from hot air dehydration and lyophilisation

Parameter	Hot air dehydrated broccoli stalk powder	Lyophilised broccoli stalk powder
Moisture (g/100g)	5.85 ± 0.07	4.89 ± 0.02
Total fat (g/100g)	0.35 ± 0.07	0.70 ± 0.00
Total protein (g/100g)	19.45 ± 0.07	21.50 ± 0.14
Total carbohydrates (g/100g)	54.90 ± 0.28	52.47 ± 0.19
Total diet fibre (g/100g)	40.40 ± 0.42	43.90 ± 0.71
Ash content (g/100g)	19.45 ± 0.35	20.45 ± 0.07

Note: Results are expressed in mean ± standard deviation

Both drying techniques produced powders with high total dietary fibre content, indicating their potential as fibre-rich functional ingredients.

Conclusions

Broccoli stalks may be effectively converted into nutrient-dense powders using lyophilisation and conventional hot air dehydration. The similar nutritional profile reveals that the drying technique is not a limiting step from a nutrition perspective. The resulting ingredients not only contain valuable macronutrients but also contribute to waste reduction and resource circularity in food production. Their incorporation into functional food formulations supports sustainable innovation and aligns with the broader goals of reducing food loss and promoting a more circular food system.

Acknowledgements

The authors are grateful to ALITEC - Alimentos Tecnológicos SA., which provided the raw material for carrying out the experiments. Furthermore, the authors would like to thank the scientific collaboration in the scope of FCT project (UID/50016/2025) and Tagus Valley for their support in carrying out the project. This work was developed under the framework of Agenda VIIAFOOD - Platform for Valorization, Industrialization and Commercial Innovation for Agri-Food, financed through the Program for Recovery and Resilience (PRR).

References

- Rabbi, M. F., & Amin, M. B. (2024). Circular Economy and Sustainable Practices in the Food Industry: a Comprehensive Bibliometric Analysis. *Cleaner and Responsible Consumption*, 14, 100206. <https://doi.org/10.1016/j.clrc.2024.100206>
- Ramírez-Pulido, B. et al. (2021). Valorization of Vegetable Fresh-Processing Residues as Functional Powdered Ingredients. A review on the potential impact of pretreatments and drying methods on bioactive compounds and their bioaccessibility. *Frontiers in Sustainable Food Systems*, 5. <https://doi.org/10.3389/fsufs.2021.654313>
- Wang, Q. et al. (2025). Valorization of broccoli waste: Unlocking its potential as a functional food ingredient for sustainable nutrition. *Journal of Advanced Research*. <https://doi.org/10.1016/j.jare.2025.07.050>