Acorn Flours: A Novel Source of Bioactives and Nutritional Benefits

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Introduction

In Portugal, acorns (*Quercus spp.*) are highly abundant, being produced around 401,585 tonnes annually. Yet, about 55% remains in fields, leading to the waste of this biomass and promoting potential environmental issues (e.g. soil degradation) (Castro *et al.*, 2022, Zhou and Wang, 2020). This challenge is further exacerbated by the increasing global population, which exerts mounting pressure on our food systems. However, acorn by-products hold great promise as a source of bioactive ingredients, offering solutions to maximize food utilization, promote upcycling, and introduce innovative nutritional and health benefits (Mahmud *et al.*, 2022) . This potential is especially evident in acorns' kernel, which is rich in valuable bioactive compounds suitable for the development of value-added products. The acorn kernel is highly abundant in phenolic compounds (e.g. tannins, quercetin, gallic acid), oil rich in fatty acids (e.g. oleic acid, linoleic acid), tocopherols, carotenoids (e.g. β-carotene), and phytosterols (e.g. β-sitosterol), which hold potential antioxidant, anti-inflammatory and anti-microbial effects (Szabłowska and Tańska, 2024). Moreover, starch recovered from the acorns' kernel can be applied as a thickening and stabilizer agent in food formulations (Castro *et al.*, 2024), and can hold promising characteristics, which can lead to the improvement of the gut microbiome.

Objectives

The present work aimed to characterize the kernel flour from two acorn species: *Quercus pyrenaica* and *Quercus rotundifolia*, provided by *LandraTech*, in a way to valorize them, through potential food applications, promoting circular economy within the industry.

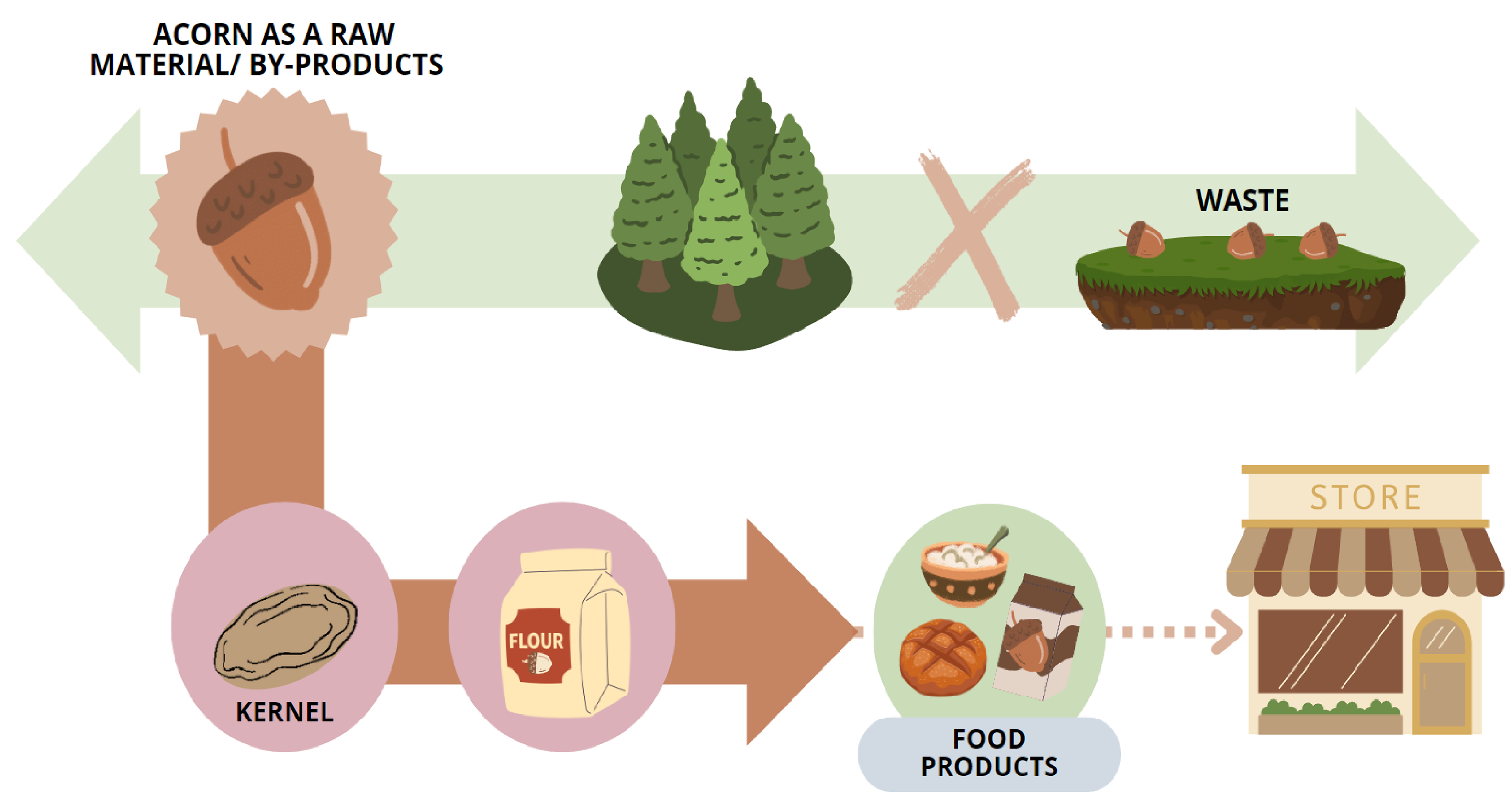

Figure 1. Acorn Kernel Flour obtention process and upcycling diagram.

Methods

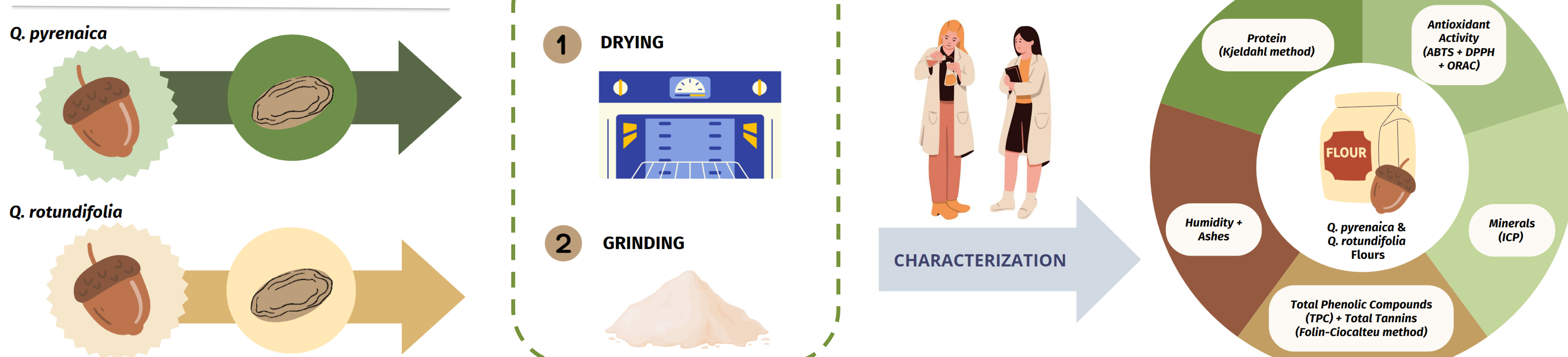

Figure 2. Flour obtention, processing and characterization methodologies diagram from the kernels of *Q. pyrenaica* and *Q. rotundifolia*, harvested in 2022.

Results and Main Conclusions

Table 1. Composition of the flours obtained from *Q. pyrenaica* and *Q. rotundifolia* kernels (DW – dry weight).

	Humidity (%)	Ashes (% DW)	Protein (% DW)
Q. pyrenaica	9.67 ± 0.01	3.55 ± 0.35	5.99 ± 0.11
Q. rotundifolia	10.05 ± 0.01	2.00 ± 0.20	4.70 ± 0.28

Table 2. Mineral composition of the flours obtained from *Q. pyrenaica* and *Q. rotundifolia* kernels (DW – dry weight; ND – not detected).

		Q. pyrenaica	*Q. rotundifolia*
Minerals (mg/100g DW)	P	118.08 ± 6.25	65.61 ± 0.96
	K	1020.99 ± 24.66	659.00 ± 6.22
	Na	ND	0.97 ± 0.20
	Ca	41.67 ± 3.59	24.09 ± 0.57
	Mg	53.35 ± 0.68	55.94 ± 1.89
	Fe	ND	6.84 ± 1.08
	Se	0.07 ± 0.01	ND
	Zn	0.13 ± 0.01	ND
	Cu	0.73 ± 0.04	0.46 ± 0.01
	Mn	1.94 ± 0.05	10.54 ± 0.11

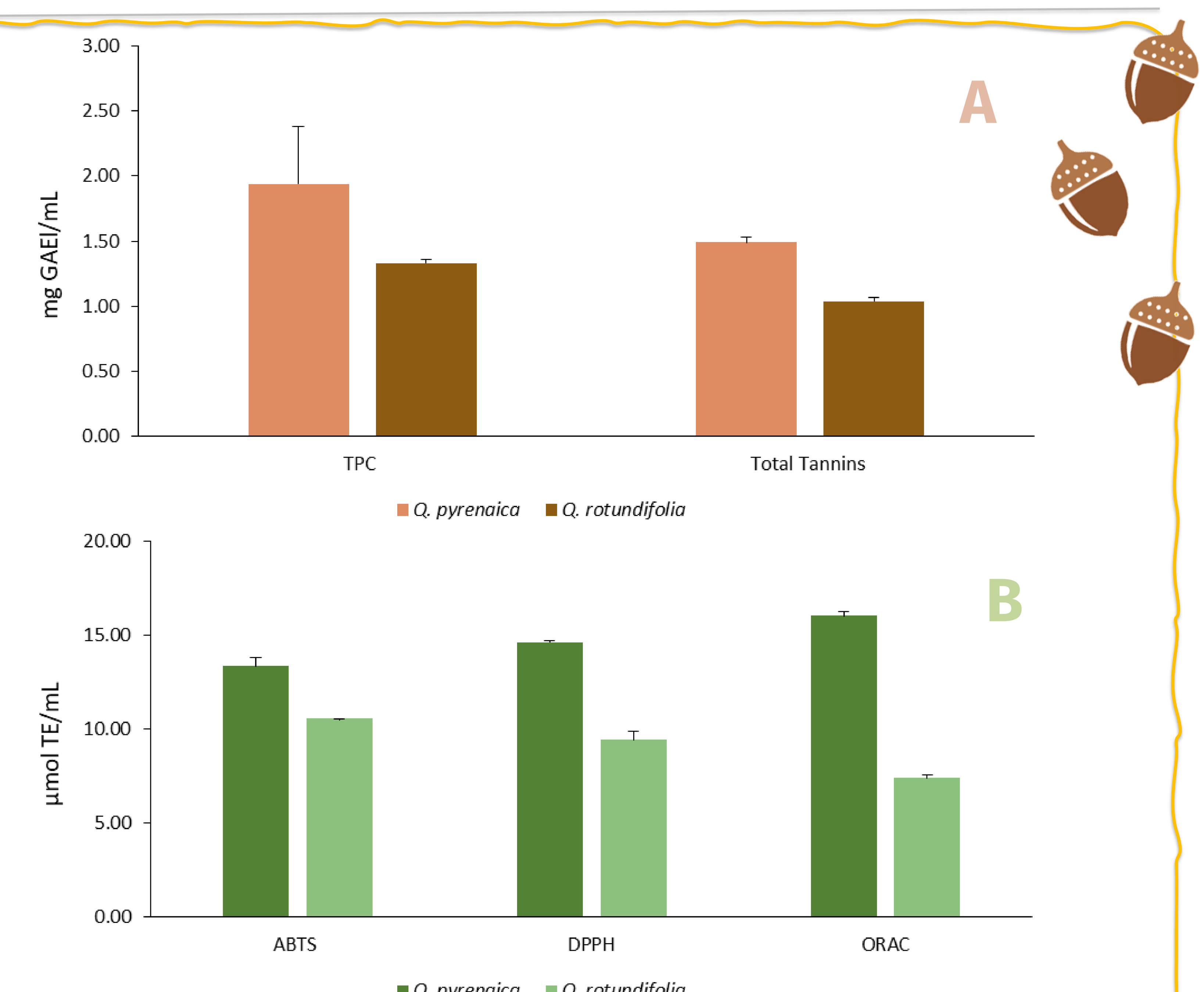

Figure 3. Differences between the flours obtained from *Q. pyrenaica* and *Q. rotundifolia* kernels regarding (A) the total phenolic compound (TPC) and total tannins composition; and (B) antioxidant capacity by ABTS, DPPH and ORAC assays.

Overall, the valorization of the acorn raw materials, exemplified by the flours obtained from its kernel, not only offers promising ways for sustainable and novel food applications, but also underlines the importance of turning waste into valuable resources in the global food industry, as a circular economy approach.

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