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Sustainable and eco-friendly strategies for the development of whisky production in Italy

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The PhD project focuses on improving the sustainability, resilience and circularity of the whisky production chain in Italy, with the aim of optimising and improving the whole process.

1. State of the Art

Whisky is defined as a spirit distilled from a mash of cereals and matured in wooden casks for at least three years[1]. The classification is according to the type of grain used, the method of blending and the country of origin. Major producing countries include Scotland, the USA, Ireland, Canada and Japan, while the largest markets by volume are India, USA, France, Japan, the UK, Spain, Canada, Brazil, South Africa and Germany [2]. In Europe, whisky production is mainly based on malted barley, water and other cereals (e.g., wheat or rye), with 150 million L of pure alcohol sold in 2022 [3]. The aroma and flavour profile of whisky is influenced by raw materials, production processes (Fig. 1.) and maturation conditions, which contribute to the quality of the final product [4,5]. Recently, the whisky industry has adopted sustainable strategies to reduce its environmental impact in terms of water (114 L/LPA) and energy (9.2 kWh/LPA) consumption at the distillery stage and lifecycle GHG emission (4.4 CO_2 eq./LPA) [6]. Approximately 2.5 kg of spent grain, 8 L of pot ale and 10 L of spent lees are produced for 1 LPA [7,8]. This project aimed to reduce environmental impact and maintain production efficiency by implementing a circular economy within the industry.

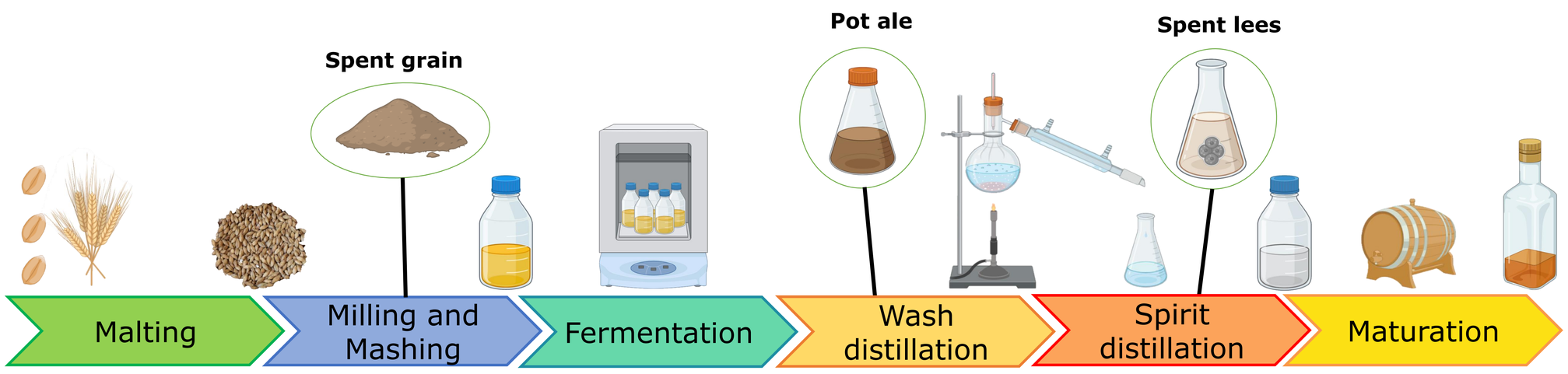

Fig.1. Whisky production and by-product generation

2. Objectives

- Research into local barley varieties suitable for whisky production, contributing to innovation and the promotion of the Italian whisky supply chain.
- Develop and optimise the whisky production process in Italy according to the principles of environmental compatibility and sustainability (PNRR) by reducing water and energy consumptionat laboratory scale for further scale-up. Part of the project will be developed in collaboration with Laboratorio Alchemico S.r.l.
- Characterisation and valorisation of whisky by-products via extraction of their bioactive compounds for food applications.

The PhD project can be divided into the following activities (Table 1):

Activity	*Months*	1	2	3	4	5	6	7	8	9	10	12	13	14	15	16	17	18	19	20	21	22	23	24
A1)	**Investigation and characterization of Italian barley varieties**																							
A2)	**Development and optimization of production process**																							
	A2.1) Malting																							
	A2.2) Fermentation and distillation																							
A3)	**By-product characterization and valorisation**																							
A4)	**Thesis and Paper Preparation**																							

Tab.1. Gantt diagram

3. Selected References

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