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SHORT COMMUNICATION

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Edible wild mushrooms of the Northern Mediterranean area - Sectorial analysis and future perspectives

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Abstract

Aim of study: Wild mushrooms are among the most widespread non-wood forest products in the Mediterranean region contributing to the rural economies. However, the wild mushroom sector still faces problems along its supply chain that can compromise its future in a scenario of increasing demand. The aim of this study was to analyse the current epigeous wild mushroom sector.

Area of study: Representative countries of the Mediterranean region: Spain, France, Italy, Croatia and Greece.

Materials and methods: The analysis was carried out through a structured Delphi survey conducted in two rounds, with a questionnaire divided into four groups: 1) supply chain description, 2) sectorial SWOT analysis, 3) future challenges and 4) sectorial resilience increase. The Delphi survey started with the selection of an expert panel that included 14 representatives of the wild mushroom supply chain such as forest owners, mushroom pickers, processing industry and consumers.

Main results: The results obtained from the expert panel confirmed the complexity of the wild mushroom supply chain with the following sectorial challenges: i) Traceability and sustainability is fundamental for the final consumer, ii) Sectorial administration should be more coordinated, iii) Mushroom picking should be regulated, as the grey market will decrease.

Research highlights: The study identified the most important actions that will strengthen the links among sectorial actors and interconnect gastronomy with mushrooms sector. The creation of a common EU list of commercial mushroom species and the development of a taxation system together with the product traceability were also addressed.

Additional key words: edible wild fungi; non-wood forest products; supply chain analysis; Delphi survey; market; policy; SWOT

Abbreviations used: NWFP (non-wood forest products), EU (European Union)

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Supplementary material (Tables S1-S5) accompanies the paper on Forest System´s website

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Introduction

Fungi are an important source of raw material for food, cosmetics, medicine and their wide uses throughout human history have been well documented (Bonet *et al*., 2020). Boa (2004) in a global study estimated that the number of wild edible fungi that have significance for people would be around 2,800 species. This number is expected to increase in the future, as new biomaterials in non-traditional sectors such as construction, textile, or plastics, are expected to be developed as part of the new bioeconomy framework (Winkel, 2017). In the last decades, an increasing public interest in nature-related activities has also attracted attention to mushroom picking activities (Górriz-Mifsud *et al*., 2017). This emerging mycotourism (Büntgen *et al*., 2017; Latorre *et al*., 2021) transforms wild forest mushrooms from being just a product to also being a service.

In Europe, wild mushroom usage is far from homogeneous. It varies from country to country; thus, wild mushrooms may be a neglected forest resource or they may represent key widespread outdoor activities (Cai *et al*., 2011; Bonet *et al*., 2014; Prokofieva *et al*., 2017). As a proxy of such European heterogeneity, Peintner *et al*. (2013), in a study of the number of authorized traded wild mushrooms in 27 European countries, highlighted the differences within countries. In spite of such big differences, wild mushrooms are the third most widespread non-wood forest product (NWFP) and their harvest generates around € 5 billion in benefits per year for companies and direct consumption by households; Mediterranean countries account for a quarter of this created value (Lovrić *et al*., 2020).

The wild mushroom sector in Southern Europe also reflects different situations and cases, not only at country level, but also at regional level within countries (Górriz-Mifsud *et al*., 2017). The lack of homogeneity among harvesting norms supposes different scenarios that range from areas in which people have free access to forests to pick mushrooms, to areas where there is a strict control of forest access (Prokofieva *et al*., 2019). The consequence of this lack of a homogeneous political framework in the European market is the uncertainty to guarantee the provision of wild mushrooms in the supply chain.

The aim of this study is to analyse the wild mushrooms sector in France, Spain, Italy, Greece and Croatia as the main productive countries of Northern Mediterranean area. This study has been carried out using an expert panel through a Delphi survey that has been proved as a useful tool for Non-Wood Forest Products sectoral analysis (Oliach *et al*., 2021; Taghouti *et al*., 2022).

Material and methods

The Delphi survey (Grime & Wright, 2016) analysed within this research consisted of statements given from the larger group of participants (164 participants in total) from 3 international workshops of the 'INCREdible' project (www.incredibleforest.net) and analysed, commented and prioritised resulting in a smaller group of experts from all segments of the proposed wild mushroom supply chain, all coming from productive countries of the Northern Mediterranean region.

The Delphi method is a forecasting technique that is used for facilitating structured group communication in order to gather a consensus of expert opinions in the face of complex and conflictual problems, providing more accurate results within the structured group than within unstructured groups (Grime & Wright, 2016).

The number of panellists per country (14 experts in total) was unevenly distributed due to the different state of the wild mushroom sector development in the targeted countries and they were asked to answer only the questions they had expertise in. The panellists were selected due to their recognized mushroom-based expertise as representatives of different supply chain positions that were previously identified within the project and they were namely: Forest and Forestry, Mushroom Pickers, Mushroom Processing and Consumers. Also, institutional and touristic supply chain actors that have impact or dependency (or both) on those four main groups were also included.

The questionnaire used in this Delphi survey was structured in the following sections: (1) description of the supply chain, (2) SWOT analysis, (3) challenges for the wild mushroom sector and (4) actions to be taken, that will increase the resilience of the wild mushroom sector. A series of statements were individually addressed to the panellists in two rounds. All of the questions / statements for the first round were identified and proposed during the three international meetings organized within the 'wild mushrooms and truffles' work group of the 'INCREdible' project, which were held in Italy, Croatia and Spain in 2018 and 2019 and where the total of 164 stakeholders participated (www.incredibleforest.net, accessed on 14th of January 2022). The results of the first round were individually collected but treated on aggregate way, requesting the panellists to confirm their position in the second round in view of his first-round answers and the average of the expert panel.

Results and discussion

The wild mushroom supply chain is gaining in complexity. In spite of the differences in the weight of the different operators within the countries, the generally accepted description of the wild mushrooms supply chain identified in the frame of the 'INCREdible' project (Brenko *et al*., 2018; Bonet *et al*., 2021) includes four main groups: 'Forest and Forestry', 'Mushroom pickers', 'Mushroom processing' and 'Consumers'. Different interactions between the four main groups of the supply chain and influences from institutional or other actors (*e.g.* Tourism) are described in Figure 1. During the second round, panellists were asked to

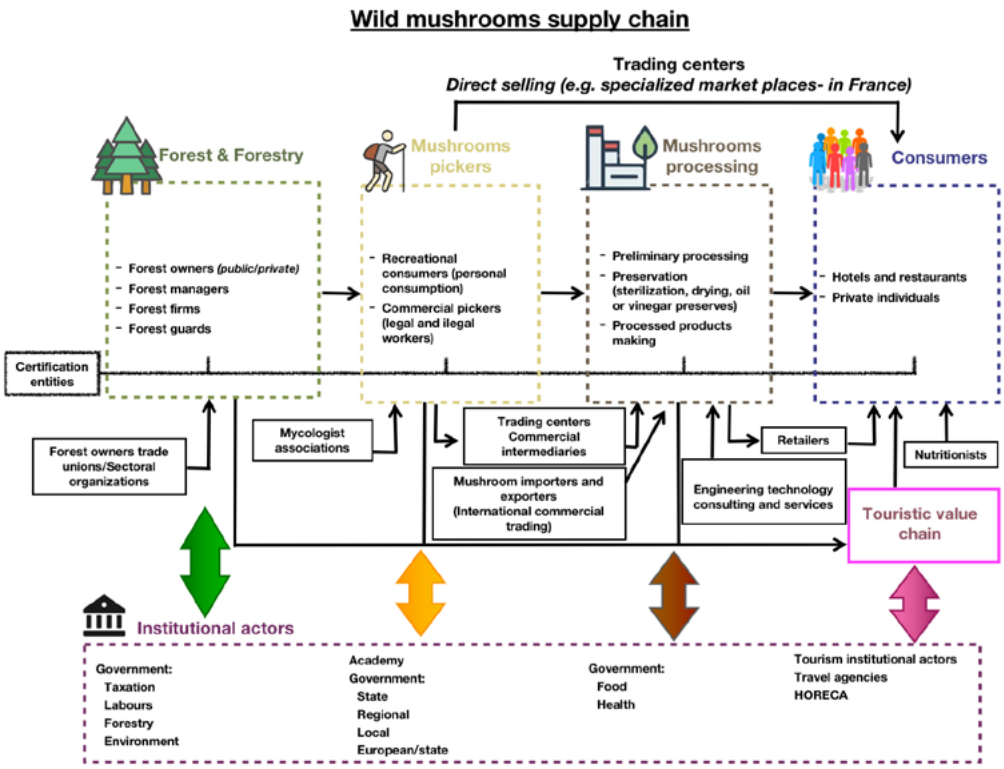

Figure 1. Supply chain of the wild edible mushroom sector in the Northern Mediterranean identified within the 'INCREdible' project.

estimate the percentage of traded wild mushrooms sourced from informal or grey markets (Table S1 [suppl]). Although the experts from Italy did not agree with the statement that almost 98% of the fresh mushrooms that are entering the supply chain are arriving from informal or grey markets, two experts agreed that this percentage equals the share of imported products and other two experts agreed that only one third or less than half of the total quantity of fresh mushrooms on the Italian market come from the formal market. While there was no data for France about this issue because the panellists could not estimate this percentage, all experts from Spain agreed that between 40% and 90% of the total quantity of fresh mushrooms that are entering the supply chain arrives from informal or grey market. Croatian and Greek experts agreed that around 90% of fresh mushrooms are entering their supply chains from informal / grey markets. The lack of data on collection, processing and trade explains why informal grey markets are being further darkened. The predominance of grey and informal markets, limits statistical analysis potential in many countries and failure to harmonise terminology are some of the key challenges that need to be overcome (Martínez de Arano *et al*., 2021). To overcome the lack of sectorial organization with informal markets, future supply chains should improve the visibility of traded wild mushrooms and the traceability of the sector.

The expert panellists also contributed to forecast the future of the wild forest mushrooms supply chain. On the question 'How the supply chain will change in the next decade in the Mediterranean Europe (Italy, Spain, France, Croatia, Greece)?', three statements can be identified, while the other are given in Table S2 [suppl]: (i) traceability and sustainability are fundamental for the final consumer, while recreational pickers will increase, and mycotourism will further grow, (ii) sectorial administration will be more coordinated, and (iii) mushroom picking will be regulated and the grey market will decrease. NWFP supply chains do not differ from other NWFP supply chains, as far as the asset of property and harvesting rights allow actors with an economic interest to organize themselves transparently. In some cases (*e.g.* for mushrooms, truffles, berries), recreational or non-professional pickers provide most of the raw material in the market and as a consequence the products and cash flow are difficult to trace. As stated by Pettenella *et al.* (2019) the core problem of the NWFP supply chain is the transfer of the product, either formally or informally, from the forest to the first formal economic actor of the supply chain.

Top ranked strength (Table S3 [suppl]) of the wild mushroom sector was identified to be its relevance to tourism. Particularly chefs and nutritionists have a strong interest in the promotion of mushrooms' gastronomic value with excellent added-value possibility (scored 8.2 out of 10), agreeing with the findings of Latorre *et al.* (2021). The greatest weakness of the sector was identified as the lack of sectorial organization with informal markets and operators not compliant with the legal regulations in the Mediterranean Europe (scored 8.6 out of 10 in 1st round

of the survey and 8.1 in the 2nd round). The creation of a common market organization specific for wild mushrooms (with common health procedures and labelling) was identified by all experts as the main opportunity (scored 9.3 out of 10), as also stated by Pettenella *et al.* (2019). The highest threat identified by the panellists was in the lack of legal control for several supply-chain actors (scored 7.8 out of 10).

Although the absence of a unified legal framework for the mushroom market at the European level is defined as a weakness, the fact that such a legal framework exists points to the lack of an information distribution channel or to a weak connection between institutional and production / consumer actors within the supply chain (Prokofieva *et al.,* 2019). A unified legal framework on such level will not change the national regulations of any given country. A similar scenario is described in highly ranked opportunity of developing a common market organization specific for wild mushrooms with common health procedures and labelling. These are already defined by Regulations No 852/2004 (EC, 2004) and No 1169/2011 (EU, 2011) of the European Parliament and of the European Council on the hygiene of foodstuffs and on the provision of food information to consumers.

The sector challenges have been split according to the different supply chain positions: production and harvesting, transformation, commercialization, mycotourism, education, training and awareness (Table S4 [suppl]). A better coordination of different administrative levels that intervene with mushroom-related activities was ranked as the highest challenge among the panellists (scored 9 out of 10). Other statements such as the development of common quality standards and the release of labels and certification (both scored 7.1 out of 10) were also considered as important. The development of traceability, labels, regional and cooperative brands and certification are the highest ranked challenges of the commercialization sector (score 6.7 / 10).

The potential impact of wild mushrooms on tourism and gastronomy is best described through the recent growing interest in mycotourism. Mycotourism is an innovative tourist product linked to rural tourism and it is promoted as an alternative use of forest resources (Latorre *et al*., 2021). In some regions, like Castilla y Léon in Spain, nearly 40% of the total returns comes from mycological resources (Martínez de Arano *et al*., 2021) whilst in Mexico, Thomé-Ortiz (2020) suggests that mycotourism can generate the economic, environmental and social dimensions of sustainable development. Other successful examples of mycotourism development can be found in France, Italy and recently in Greece (Nwfps.org Knowledge Repository, 2022), but they are not equally developed in all Mediterranean countries. The lack of common legislation and regulations at the European Union (EU) level block many opportunities identified through this survey. Such opportunities could be the development internationally of a common market organization or the promotion of mushroom gastronomy around the less commonly used species. The lack of control among various supply chain stakeholders is a threat recognised by experts from all surveyed countries. This indicates the need to develop stronger vertical connections within the supply chain, *e.g.* a direct and stronger link between institutional stakeholders (taxation), mushroom pickers and final consumers. Differences in harvesting regulations among countries may have considerable effects on NWFP markets: if collection of a certain NWFP in a country is restricted, a displacement of the supply chain may occur as economic stakeholders will seek supply from another country with less stringent regulations. Products that cross national borders may require common policies, especially for strategically important resources (Prokofieva *et al.*, 2019).

During the 'INCREdible' project, 11 priority actions were identified that could increase the resilience of the wild mushroom sector (Table S5 [suppl]). The creation of a common list of mushrooms that can be commercialized freely in EU was defined as the most important action. This expert's opinion matches with the findings of Peintner *et al*. (2013) who featured the differences in numbers of listed mushrooms species that can be commercialized in various European countries, also suggesting the development of a comprehensive list of species and requested analysis by the European Commission where all edible and toxic species should be identified. This list would then serve as a foundation for national lists, minimising the differences between countries and lowering the importance of some poorly described edible species found only in certain areas. This suggestion was also ranked as a priority action by our experts. Such a list could ease the process of defining common market regulations, traceability system developments and common quality standards, thus resolving the priority challenges identified from the survey.

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