



Conservation Strategies of the Culinary-Medicinal Mushroom *Pleurotus nebrodensis* (Basidiomycota, Fungi) †

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Abstract: *Pleurotus nebrodensis* (Inzenga) Quél. is an edible mushroom appreciated by consumers for its organoleptic characters. It was first described by the mycologist Giuseppe Inzenga as “the most delicious mushroom growing in Sicily”. This taxon, originally described as *Agaricus nebrodensis* Inzenga, has undergone several changes in the synonymy and is recognized as a variety or subspecies within the *Pleurotus eryngii* (DC.) Quél. species complex. Recent studies demonstrated that *P. nebrodensis* is distinct from other taxa related to the *P. eryngii* complex. The distribution of *P. nebrodensis* in Europe is limited. The mushroom grows only in Madonie Park (Sicily, Italy) and in Greece, associated with plants of *Prangos ferulacea* (Lindl.). Several studies demonstrated that the presence of *P. nebrodensis* in native territories has progressively decreased over the years. Research conducted in Sicily (southern Italy) during the fructification period (April–June 2009) confirmed this negative trend. The decision to include *P. nebrodensis* as an endangered (EN) species on the IUCN Red List of Threatened Species was taken to safeguard the existence of this important taxon. Legal action is needed to stop the overexploitation and collection of unripe basidiomata of *P. nebrodensis* in the wild. Ex situ cultivation to increase wild production was experimented and preservation of mycelium in the Mycotheca of the Department of Agricultural, Food, and Forest Science (SAAF) of the University of Palermo was carried out. The in situ conservation strategy can be implemented only if the wild collection is properly managed (picking of ripe mushrooms forbidden in zone A of Madonie Park and collection of unripe mushrooms forbidden in other areas).

Keywords: *Pleurotus nebrodensis*; Basidiomycetes; ex situ conservation; in situ conservation; exploitation



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1. Introduction

Species belonging to the genus *Pleurotus* (Fr.) P. Kumm. are appreciated worldwide for several aspects such as culinary, nutritional, and medicinal properties [1]. Over the years, the taxonomy of the genus *Pleurotus* has been controversial; this has led to misinterpretations and a subsequent confusion in labelling of the different commercial strains [2]. Among the different species belonging to the genus *Pleurotus*, one of the most interesting, from a culinary and medicinal point of view, is *Pleurotus nebrodensis* (Inzenga) Quél. (Figure 1), which is one of edible mushroom species most appreciated by consumers. It was first described by the mycologist Giuseppe Inzenga as “the most delicious mushroom growing in Sicily” [3]. This taxon, originally described as *Agaricus nebrodensis* Inzenga, has undergone several changes in the synonymy and is recognized as a variety or subspecies within the *Pleurotus eryngii* (DC.) Quél., but, as reported by Venturella et al. [2], *P. nebrodensis* is different from other taxa related to the *P. eryngii* complex. In previous studies, *P. nebrodensis* was reported with a distribution restricted only to Sicily on the Madonie

Mountains, but afterwards, its presence was also confirmed in continental Greece. In nature, its presence is linked to *Prangos ferulacea* (L.) Lindl., a perennial herbaceous plant belonging to the Apiaceae family, characteristic of mountain pastures [2]. Basidiomes are firm and fleshy, and ivory colored with brownish squamules. The pileus surface must be polished or translucent, dry, cracked, and smooth or glabrous. The consistency of pileus flesh is turgid and cream-colored, with no color variation. The flavor is mild and slightly floury. Lamellae are light ivory-colored. The stem, which is fibrous and tough in texture, with a smooth, light ivory-colored surface, laterally or centrally connects the pileus with the root or residual stem of *P. ferulacea*. Fructification occurs between April and June, showing solitary or gregarious growth [4].



Figure 1. Basidiomata of *Pleurotus nebrodensis*.

For several centuries, Sicilian populations have appreciated the excellent organoleptic qualities of these mushroom, which have thus acquired a high commercial value, especially in the territories adjacent to the Madonie mountains [5]. In addition to organoleptic characters, in vitro experiments have demonstrated the ability of *P. nebrodensis* extracts to specifically inhibit colon cancer cell proliferation by inducing apoptosis [6] and the antibacterial activity expressed on different bacteria of medical relevance [7].

Field surveys carried out in the area of distribution over the years have confirmed a decrease in the number of *P. nebrodensis* basidiomes during the fruiting period. This negative trend is due to both the excessive pressure of mushroom pickers, moved by the high commercial value of this mushrooms, and climatic changes, such as progressive soil erosion, habitat modification, and rainfall irregularity [4].

For all of these reasons, the decision to include *P. nebrodensis* on the IUCN Red List of Threatened Species initially as “critically endangered” (CR) and following the survey of individuals in Greece as “endangered” (EN) was made to safeguard the existence of this important taxon [8].

2. Methods

Field investigations were carried out in Italy and Greece to verify the presence of basidiomata of *P. nebrodensis*. Macroscopic and microscopic features were evaluated. Macroscopic features include the pileus size, shape, and color; margin shape and surface; pileus surface and flesh; lamellar characters; stipe characteristics; presence or absence of veil on stipe; type of basidioma attachment; and spore print. Colors refer to the RAL matching system. Microscopic features evaluated were the hyphal system; hyphal wall; septations; hyphal branching; hyphal inflations; specialized hyphae; pigmentation; type of pellis; trama, position, type, shape, pigmentation, and incrustations of cystidia; basidia and basidioles; spore features; and chemical reactions. Exsiccata and strains are preserved in the SAAF fungal dried reference collection of the University of Palermo.

3. Results and Discussions

3.1. In Situ Conservation

In the A zone of the Madonie Regional Park, the collection of *P. nebrodensis* basidiomes is forbidden, because they are under total protection, while the collection of unripe mushrooms (i.e., with a diameter of pileus less than 3 cm) is forbidden throughout the park. Unfortunately, the level of control by forest rangers has been insufficient to prevent an increase in pressure by mushroom pickers in the collection sites. Even if they are protected by regulations of the Madonie Park and by the Regional law n. 3 (1 February 2006), unripe basidiomes are still harvested each spring, increasing the decline in *P. nebrodensis*.

3.2. Ex Situ Conservation

3.2.1. Cultivation

In order to decrease the pressure carried out by mushroom pickers, cultivation has been developed for *P. nebrodensis* (Figure 2). This methodology uses tunnels of variable length, generally between 20 and 30 m, shaded to 90% by the application of a dark shading net; this technology allows cultivation at various altitudes [9]. Cultivated *P. nebrodensis* have been found to maintain similar organoleptic characteristics to wild ones [10]. The ex situ cultivation reduces the pressure by harvesters on the wild population, as well as being a source of additional income for local farmers, because a product of such quality can be available more than in the wild and sell at a lower price [5].



Figure 2. Mycelial grains for ex situ conservation.

3.2.2. Fungal Culture Collection

Another type of ex situ conservation is the development of strains in our laboratory in the university. The preservation of mycelium is carried out in the Mycotheca of the Department of Agricultural, Food, and Forest Science (SAAF), University of Palermo [11]. Other strains are available in the Laboratory of General and Agricultural Microbiology of the Agricultural University of Athens [8].

4. Conclusions

The Convention on Biological Diversity (CBD) includes fungi as organisms of a high diversity level to investigate and to protect. In fact, fungi form a major part of global biodiversity representing 10–20% of the total number of species of life.

Red-list evaluations produced over the last two decades in Europe indicate that a range of 2000–3000 species of macrofungi throughout Europe are declining and their futures are uncertain. Fungi are rarely considered in national conservation actions and are not considered in any international conservation agreements (e.g., Bern Convention and Habitat Directive).

This is very much the case of *P. nebrodensis*, which is included in the IUCN Red List of Threatened Species, but still lacks adequate protection by regional administrations. There is no doubt that a definite increase in protective actions will be beneficial to *P. nebrodensis* and the habitat in which it grows. In this regard, the involvement of local populations will be of fundamental importance and it will be necessary to underline the advantages of maintaining this natural resource for future generations.

The preservation of *P. nebrodensis* is even more necessary today if we refer to the benefits that the extracts of this culinary-medicinal mushrooms have on human health.

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