

## *Grifola gargal* and *G. sordulenta*, Two Wild Edible Mushrooms with Perspectives as Biotech Products

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### Abstract

*Grifola gargal* Singer and *Grifola sordulenta* Mont. (Singer) are two edible and medicinal mushroom species which occur in the Andino-Patagonian forests of Argentina and Chile. These woods that mainly consist of *Nothofagus* spp. are under increasing pressure with the consequent need of finding alternative sources for these mushrooms rather than gathering them. The main interest in these species is their culinary properties, which include a characteristic almond flavor present in the basidiomes, mycelium from submerged culture and solid-state fermented substrates, as well as the closely related *Grifola frondosa*, a well-known medicinal mushroom.

In recent years *G. gargal* and *G. sordulenta* have been studied for both their medicinal properties and culture conditions by researchers from Argentina, Chile, Japan and USA. However, neither industrial application nor commercial production has been undertaken. In this situation, a relevant role for fermentation technologies to develop possible future products from these wild-grown mushrooms is emphasized. Indeed, biotransformed wheat grains obtained through solid-state fermentation showed antioxidant and antigenotoxic activities which were comparable with those recorded from mycelium and basidiomes. The article comments on the up-to-date findings and state of research of these novel species, emphasizing some future research topics.

**Keywords:** Antioxidant; Mushrooms; Mycelium; Solid-state fermentation; Wheat grains

### Commentary

The biodiversity of native Patagonian woods in both Argentina and Chile persists thanks to the existence of regulated protected areas and the efforts of teaching the values of forest diversity to local residents. There is concern about some endemic mushrooms that are declining as they are gathered for food and this type of impact is not well known and could potentially affect the ecological balance. Among them, *Grifola gargal* (known as “gargal or galgal”) and *G. sordulenta* (no known common name) are two novel species belonging to the Polypore family that are related to *Grifola frondosa* (known as “maitake”).

The latter is a well-known mushroom which possesses both demonstrated medicinal properties and biotechnological applications. Indeed, *G. frondosa* polysaccharides, phenolics and other molecules have been subjected to medicinal property studies and, certainly, some pharmaceutical products have been developed. Moreover, as a white rot fungus, its enzyme profile was evaluated for possible biotechnological applications.

The interest in both the edible and medicinal properties of *G. gargal* and *G. sordulenta* started in 1999, when researchers from Talca University (Chile) reported on the composition and biological activities of several herbs used by natives, including three species of mushrooms. Samples of *G. gargal* basidiomes were analyzed in respect to the nutritional content and biological activity [1]. This study showed a moderate effect in the DNA binding assay and also a strong hypotensive response in rats caused by *G. gargal* basidiomes collected in Valdivia (Chile).

By 2006, the first cultivation method approach was reported by Postemsky et al., [2]. An optimized method for agar culture and liquid culture was presented for both *G. gargal* and *G. sordulenta*. Starting with this report, a series of studies followed with the evaluation of different methods for obtaining *G. gargal* and *G. sordulenta* biomass through different culture systems at laboratory and pilot scales. These studies were supported by the Argentine Research Council and the Universidad Nacional del Sur (Argentina). The original specimens of these mushrooms were collected in the Lanín and Los Alerces National Parks (Argentina) for *G. gargal* and *G. sordulenta*, respectively.

A short time later, scientists from the University of Concepción and the National Institute of Agricultural Research (Chile) firstly described in detail the antioxidant activity of *G. gargal* basidiomes collected in Osorno (Chile), emphasizing the phenolics role in several *in vitro* assays activity [3,4]. More recently, an antioxidant activity report was presented by Postemsky and Curvetto [5], describing this attribute in mycelium extracts from both *G. gargal* and *G. sordulenta* obtained by different submerged culture methods and compared with liquid cultured mycelia from *G. frondosa* and basidiomes samples of *G. gargal*. This report illustrates how culture conditions can affect the antioxidant activity and phenolic content. Indeed, radical scavenging activity and the reduction power on ferrous ions were affected in different ways by either media components, the vessels used or the agitation speed. Auspiciously, some treatments showed a considerably higher activity than those that had previously been obtained with *G. gargal* basidiomes and *G. frondosa* mycelia. Also Harada et al. [6], recently reported the amelioration of atherosclerosis and the enhancement of regulatory T cells in a mouse model using *G. gargal* extracts of the basidiomes.

Development of protocols for the commercial production of *G. gargal* or *G. sordulenta* have not been achieved so far. However, some advances using artificial substrates and the classical methods for lignocellulolytic mushroom culture were reported by Shen and Royse [7] and Postemsky and Curvetto [5]. The constraint of basidiome supply may be a risk factor for natural populations due to the fact that the other alternative is to gather them from their habitats. Such activity can impose great danger to natural populations considering their low

abundance in the forest, where they mainly grow in relicts of the native *Nothofagus* tree species (*N. obliqua* and *N. dombergii*), although a certain ability to colonize other substrates was reported by Pozzi et al. [8], who described *G. gargal* colonizing the dead tissues of a poplar tree.

However, considering this scenario, it can be seen that these facts show that there is an opportunity for fermentation technologies to produce mushroom mycelium and molecules, using either submerged fermentation or solid-state fermentation. With this aim, Postemsky and Curvetto [9], produced a functional flour in a pilot-scale based on solid-state fermentation of wheat grains. Such biotransformed wheat grains presented the characteristic almond flavor, increasing the antioxidant capacity of wheat grains, but, was the beneficial biological activity found in a fermented substrate comparable to that obtained with mycelium or basidiomes? This hypothesis was shown to be true by performing an in vivo antigenotoxic assay using *Drosophila melanogaster* as the experimental model (Postemsky et al.) [10]. Fly larvae were cultured in a media containing the three above mentioned sources of *G. gargal* in combination with an anthropogenic carcinogen of anthracene nature. Moreover, a comparable effect of biotransformed wheat flour and mycelium from a submerged culture were found in *G. sordulenta* (unpublished results).

In addition, a recent report described the solid-state fermentation conditions of other substrates, including grains and sunflower seed hulls (Postemsky and Curvetto) [5]. In this study, it was described that almond aroma was present in any form of colonized substrate; moreover, it was found that sunflower seed hulls increased their protein content and laccase activity and also reduced the lignin fraction as a result of biodegradation. These analyses support further studies on the metabolic purification of interesting flavoring compounds, on pharmaceutical grade metabolites, such as ergothioneine, as was reported by Ito et al. [11], and also on enzymes for biotechnological purposes.

Future research on *G. gargal* and *G. sordulenta* may show if any of the different strains of these species, or even new ones (collected from noticeably different natural conditions), respond satisfactorily to artificial culture conditions. On the other hand, it must be evaluated whether different strains present distinctive biological activity, including the study of the effects of substrate composition and/or

fermenting conditions on their metabolomic regulation. And, finally, research is necessary to compare the antitumoral and immunomodulatory activity of these species with the well-established medicinal mushroom *G. frondosa*.

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