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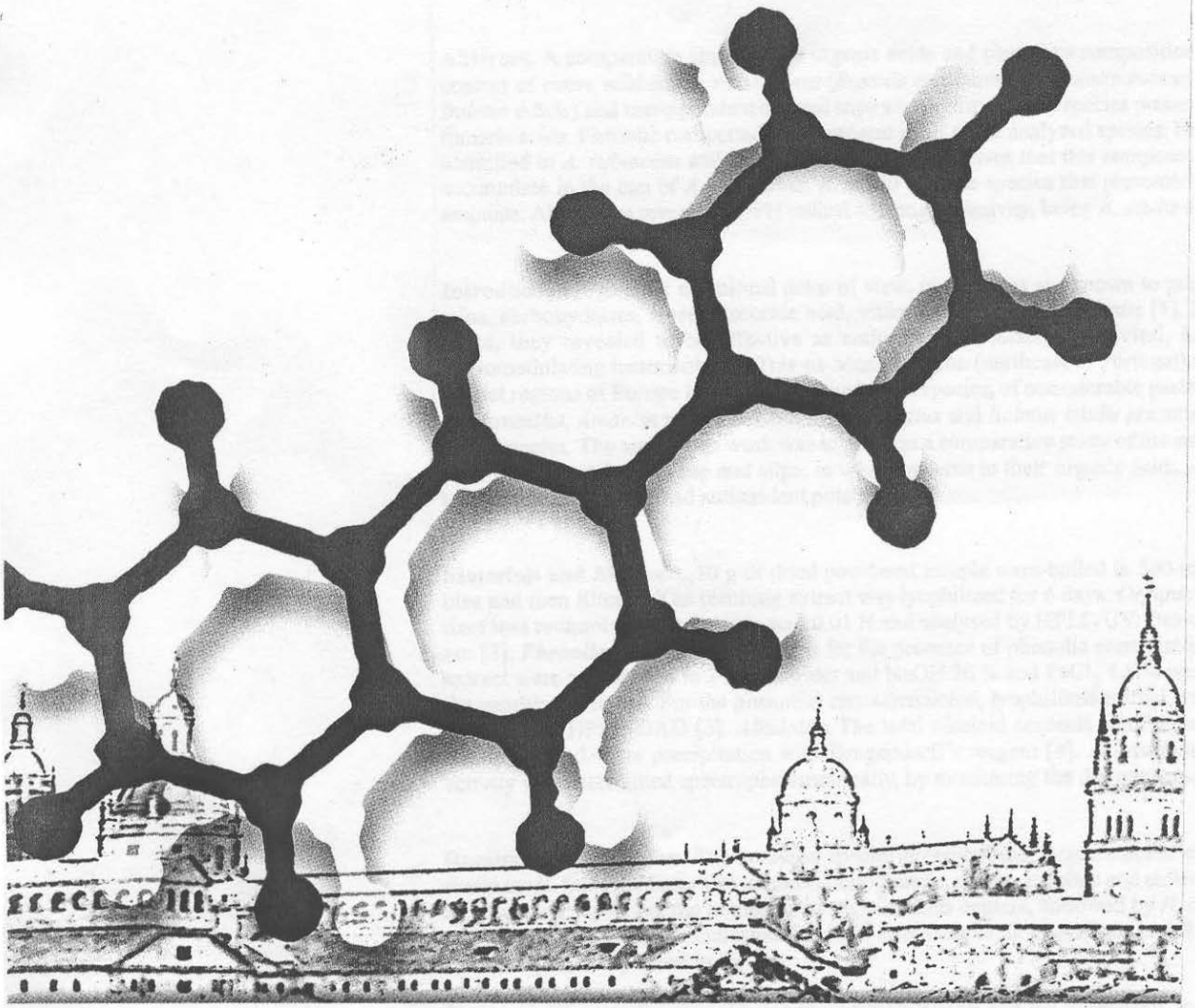

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Antioxidant potential and relation with chemical composition of wild edible mushrooms cap and stipe

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Abstract. A comparative study of the organic acids and phenolics composition and of the total alkaloids content of entire wild edible mushrooms (*Russula cyanoxantha*, *Amanita rubescens*, *Suillus granulatus* and *Boletus edulis*) and correspondent cap and stipe was performed. All species presented oxalic, citric, malic and fumaric acids. Phenolic compounds were present in all of the analyzed species, being *p*-hydroxybenzoic acid identified in *A. rubescens* and *S. granulatus* species. It seems that this compound may have a propensity to accumulate in the cap of *A. rubescens*. *B. edulis* was the species that presented the highest total alkaloids amounts. All species revealed DPPH radical scavenging activity, being *B. edulis* the most effective one.

Introduction. From the nutritional point of view, mushrooms are known to possess high amounts of proteins, carbohydrates, fibers, ascorbic acid, vitamins and low fat contents [1]. Regarding their medicinal value, they revealed to be effective as antitumor, antibacterial, antiviral, haematological and in immunomodulating treatments [2]. Trás-os-Montes region (northeast of Portugal) is recognized as one of the richest regions of Europe in wild edible mushroom species, of considerable gastronomic relevance. *Russula cyanoxantha*, *Amanita rubescens*, *Suillus granulatus* and *Boletus edulis* are among the more common and eaten species. The aim of this work was to perform a comparative study of the entire mushroom species and their fundamental parts, cap and stipe, in what concerns to their organic acids and phenolics composition, total alkaloid contents and antioxidant potential.

Materials and Methods. 10 g of dried powdered sample were boiled in 500 mL of water during 30 minutes and then filtered. The resulting extract was lyophilized for 6 days. *Organic acids.* The lyophilized extract was redissolved in sulphuric acid 0.01 N and analysed by HPLC/UV. Detection was performed at 214 nm [3]. *Phenolic compounds*: To check for the presence of phenolic compounds, ca. 0.25 g of lyophilized extract were redissolved in 2 mL of water and NaOH 20 % and $FeCl_3$ 4.5 % were added to two aliquots of the resulting solution. For the phenolics characterization, lyophilized extract was redissolved in water and analysed by HPLC/DAD [3]. *Alkaloids.* The total alkaloid contents were determined by a spectrophotometric method, after precipitation with Dragendorff's reagent [4]. *Antioxidant potential.* The antiradical activity was determined spectrophotometrically, by monitoring the disappearance of DPPH at 515 nm [3].

Results and Discussion. The analysed species presented four organic acids: oxalic, citric, malic and fumaric acids. Some of them also exhibited ketoglutaric, quinic, succinic and shikimic acids. In a general way, *A. rubescens* presented the highest total organic acids content, followed by *R. cyanoxantha*, *S. granulatus* and *B. edulis*. The results indicated that in *R. cyanoxantha*, *S. granulatus* and *B. edulis* species the organic acids are preferably fixed in the cap.

The screening tests for phenolic compounds with NaOH and $FeCl_3$ revealed their occurrence in all of the analyzed species. The presence of these compounds in wild edible mushrooms is scarce [5-7]. In the present study, phenols with absorption maxima around 260 nm were detected in the four species, although it was not possible to identify them. *p*-Hydroxybenzoic acid was found in *A. rubescens* and in *S. granulatus*. Concerning *A. rubescens*, *p*-hydroxybenzoic acid was found both in samples of the entire mushroom and of the cap, but not in the stipe, which suggests that this compound may have a propensity to accumulate in the cap. The analysis of *S. granulatus* allowed the identification of *p*-hydroxybenzoic acid in the cap or in the entire mushroom. As far as we know, it was the first time that *p*-hydroxybenzoic acid was identified in *S. granulatus* species.

The quantification of total alkaloids revealed that *B. edulis* was the species presenting significantly higher contents of these compounds. Excepting for this species, the cap showed a tendency to be richer in alkaloids. The antioxidant potential of the different mushroom materials was evaluated by their DPPH scavenging effect. All analysed species presented antioxidant activity, which revealed to be concentration-dependent. *B. edulis* exhibited the highest capacity (Figure 1) which may be related with its high alkaloids content. In *R. cyanoxhanta* species, citric acid concentration was considerably higher in the cap while the stipe contained the lowest amount of this acid. These data suggest that citric acid may be important for its antioxidant capacity. Regarding *A. rubescens*, the presence of *p*-hydroxybenzoic acid may not be relevant for the antioxidant activity, once it was present in higher amounts in the cap than in the entire mushroom, which displayed the minor and the strongest antioxidant effect, respectively. Regarding *S. granulatus*, the relevance of phenolic compounds could not be evaluated, since *p*-hydroxybenzoic acid was detected only in the entire mushroom. This compound most probably does not play an essential role in the antioxidant activity of this species as it is absent in the cap, which exhibited the highest potential. In general, the cap was the material that contributed the most to the antioxidant activity of all species.

The variety of compounds and the antioxidant potential revealed represent an important contribution for the knowledge of wild edible mushroom species of great consumption and for their possible beneficial effect in the human health.

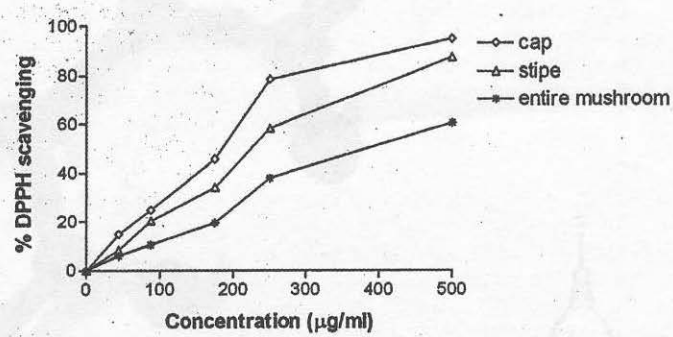

Figure 1. DPPH scavenging activity of B. edulis. Values show mean ± SE from 3 experiments performed in triplicate.

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