Microbiological and chemical composition of some Portuguese hazelnuts

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Hazelnut is one of the most popular dried fruit all over the world, because of its unique organoleptic characteristics and also due to its nutritional composition [1]. The characteristics of the different hazelnut varieties that exist worldwide are dependent of several factors, such as, the genotype, agricultural and post-harvest practices, climatic conditions and also the geographical location where they are cultivated. Moreover, hazelnut quality is also affected by its chemical composition [2]. The aim of this study was to access the microbiological quality and also the chemical composition of three hazelnut varieties (Grada de Viseu, Tonda de Giffoni and Butler), cultivated in the Viseu region, Portugal. Therefore, hazelnut kernels were analysed for moisture, water activity, fat, protein, fibre and ash. Furthermore, there also quantified the microorganisms at 30ºC and the moulds and yeasts at 25ºC. All analysis were performed in triplicate. According to the results, fat was the major chemical component for all varieties, varying from 64.38±1.67 g/100 g (var. Grada) to 78.16±1.71 g/100 g (var. Tonda), with statistically significant differences between the varieties ($p<0.0005$). Moisture content was higher for the var. Butler (6.02±0.37 g/100 g) and lowest for the var. Tonda (4.86±0.33 g/100 g), with statistically significant differences between the three varieties under study ($p=0.013$). According to the recommendations of the European Union, moisture content of hazelnut kernels should not exceed 6.0% [3]. As for the water activity, the values ranged from 0.54±0.01 (var. Butler) to 0.56±0.01 (var. Grada), but in this case with no statistically significant differences between the varieties. The var. Butler presented the fruits with the higher ash content (2.31±0.18 g/100 g), while var. Grada was the one with the lowest value (1.69±0.16 g/100 g), again with statistically significant differences ($p=0.012$). The var. Grada presented the higher fibre (6.13±0.03 g/100 g) and protein content (22.84±0.18 g/100 g), with statistically significant differences among the varieties in the two cases. The results also showed (Table 1), that according to the limits established for the count of microorganisms at 30ºC and mould and yeast by the National Health Institute Doutor Ricardo Jorge [4] (<10^6 CFU/g for microorganisms at 30ºC, <10^5 CFU/g for yeast and <$5x10^2$ CFU/g for moulds), all the varieties presented a satisfactory microbiological quality, with statistically significant differences between the varieties in the case of the quantification of microorganisms at 30ºC. Moreover, as it can be observed in Table 1, var. Butler presented the highest values for the microorganisms at 30ºC and also for the moulds and yeast at 25ºC, which may be explained by its higher moisture content. The results of this study are very important to characterize the microbiological quality and also some chemical properties of the three most representative hazelnut varieties cultivated in Portugal.

Table 1. Mean count (log CFU/g±standard deviation) of total microorganisms at 30°C and moulds and yeasts at 25°C of the samples under study (n=3).

Sample	Microorganism at 30ºC[1]	Mould and Yeasts at 25ºC[1]
Grada de Viseu	2.84**±0.03**[b]	2.40**±0.07**
Tonda de Giffoni	2.61**±0.03**[a]	2.46**±0.04**
Butler	2.90**±0.01**[c]	2.47**±0.03**
p-value	<0.005	0.059

[1]Mean values in the same column with the same letter are not statistically different ($p>0.05$)

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Chemical characterization of Cistus ladanifer L. phenolic extract and its antifungal activity against Botrytis cinerea

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Botrytis bunch rot, caused by *Botrytis cinerea*, is an important disease of grapevines in temperate climates worldwide. It can cause extensive economic losses through grape desiccation, rot, and biochemical changes that reduce wine quality. Therefore, it is crucial to identify new compounds, especially natural ones, that are active against *B. cinerea*. Biofungicides from plant origin have been recommended to reduce viticulture's dependence upon synthetic fungicides for the last decades [1]. Cistus (*Cistus ladanifer* L.) is a perennial shrub from the Cistaceae family that can be found in abundance in the Mediterranean's marginal fields [2]. Moreover, cistus phenolic extract has been described as a potential antifungal agent, due to its interesting phenolic composition, including ellagitannins and flavonoids [3]. In this sense, the present study evaluated the antifungal potential of a phenolic extract of *C. ladanifer* from Northeastern Portugal, against *B. cinerea*. Dry leaves from cistus were extracted by maceration using ethanol: water (80:20 *v/v*) as solvent. The phenolic extracts were characterized by HPLC-DAD/ESI-MS and evaluated for their capacity to inhibit *B. cinerea* using the microdilution method. Ellagic acid derivatives (24.3 mg/g extract; 83.8%), flavonoids (3.93 mg/g extract; 13.6%), such as flavonols and flavones; phenolic acids, and derivatives (0.76 mg/g extract; 2.6%), were found in the sample (Figure 1). The most abundant group was ellagic acid derivatives in which punicalagin and punicalagin gallate, were found in the highest amounts (13.3±0.9 and 11±2 mg/g extract, respectively), being these results in line with previous studies [3]. The extract revealed an interesting capacity to inhibit the growth of *B. cinerea* at a concentration of 10 mg/mL, which could be related with the high composition in ellagitannins. Considering the bioactivity of cistus phenolic extract, this natural product could be applied as an alternative to synthetic fungicides used in the prevention and treatment of fungal infections in grapevine, minimizing the environmental and health impacts caused by these chemical agents.

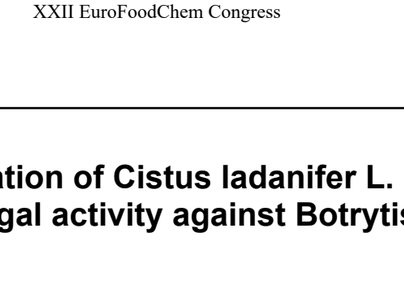

Fig.1. Cistus leaf extract phenolic composition.

Keywords: Grape pathogens; *Botrytis cinerea; Cistus ladanifer* L.; Plant extracts; Biofungicides.

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