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# COMPARATIVE ANALYSIS BETWEEN MUSHROOMS *LACTARIUS PIPERATUS* AND *AGARICUS BISPORUS* (CHAMPIGNON) USING FT-IR SPECTROSCOPY

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***Abstract***

*In the last years the consumers are in favour of edible mushrooms due to the nutritious value and potential medical value because that are rich in proteins, vitamins, mineral elements.*
*Also, mushrooms contain terpenoids, carbohydrates and very important for organism, antioxidants.*
*Lactarius piperatus and Agaricus bisporus are two well-know mushrooms which have a high nutrition and many benefits for health. Therefore, a lot of mushroom is a very interesting subject for many studies and analyzes.*
*In this sudy, a rapid method using Fourier transform infrared (FT-IR) spectroscopic was established for analysis and characterized a principal components of two types of mushrooms.*
*Vibrational spectral techniques, FT- IR, offer several advantages in the context of current research and using this techniques we can identify molecular components in the samples studied. Following the analysis of the two spectra, we can observe an increased intensity of the characteristic absorption peaks belong to proteins (1655 cm$^{-1}$), polysaccharides (1000-400 cm$^{-1}$) and amino acids.*

***Key words***: *Lactarius piperatus, Agaricus bisporus (champignon), FT-IR (Fourier transform infrared) spectroscopy.*

## INTRODUCTION

Natural products with antioxidant activity are used to aid the endogenous protective system, increasing interest in the antioxidative role of nutraceutic products (Kanter, 1998). Concerning this, the antioxidants in human diets are of great interest as possible protective agents to help human body reduce oxidative damage.
Oxidation is essential to many living organisms for the production of energy to fuel biological processes, proceeding in lipids with polyunsaturated fatty acids, and generating reactive oxygen species (ROS) such as hydroxyl radicals (Halliwell and Gutteridge, 1989).
A multitude of natural antioxidants have already been isolated from different kinds of plant materials such as oilseeds, cereal crops, vegetables, fruits, leaves, roots, spices, and herbs (Ramarathnam et al., 1995). Mushrooms become attractive as a functional food and as source for the development of drugs and nutraceuticals.
Mushrooms are highly nutritious food sources, which can be cultivated on cheap and usually readily available raw materials.
The term "mushroom" describes the reproductive structure of fruiting body of a fungus (Berch et al., 2007). Mushrooms belong to the kingdom of fungi, a group very distinct from plants, animals and bacteria. In the last years, there has been sustaining increase of commercial interest in mushrooms in pharmaceutical and food industries due to their wide usages as both food and medicine in many countries in this world (Sanmee et al., 2003).
The mushrooms have been associated to the life of human. Mushrooms are potent source of

biologically active substances which have beneficial effect on human health.

For example, most wild-grown mushrooms are rich in polysaccharides, proteins, amino acids, vitamins, and minerals, which can provide a high nutritional value for health (Ulziijargal and Mau, 2011; Kalač, 2009).

Many, if not all, mushroom species contain polysaccharides which may boost human immune system. In the last years much research have been done on biologically active substances originated from Basidiomyceteae which have beneficial effect of health and help in the treatment of many disease (Smith et al.,2002; Lindequist et al., 2005; Rajewska et al., 2004). Amoung these compounds, polysaccharides seem to play the most important role due to their anticancer. *Agaricus bisporus* (the white button mushroom, champignon) is the most commonly cultivated and consumed mushroom in Western Europe and North America. *Agaricus bisporus* is well known to mycophagists as the common "button mushroom" of commerce. The common grocery store form of *Agaricus bisporus* is completely white, but in recent years the mushroom industry has developed brown strains of the species, which it markets as "crimini" and "portobello" mushrooms (the distinction is simply that the portobellos have been allowed to mature past the button stage).

It contains high levels of proteins, carbohydrates, minerals (potassium, iron and phosphorus) and vitamins (vitamin C, niacin and thiamine), and is low in fat and calories (Clarke, 2007; Wu et al., 2006).

Analysing *L. piperatus* for constituents such as moisture, fat, proteins, ash and carbohydrates, Barros et al. (2007) showed that while protein and unsaturated fatty acid levels increased with the fruiting body maturity stage, the carbohydrate and saturated fatty acid content decreased. The maturity of the mushroom stage had little effect on individual sugar composition.

Methanol extracts from *Lactarius piperatus* have been investigated for antimicrobial activity. Using agar disk diffusion assays, *L. piperatus* revealed antimicrobial activity against *Escherichia coli, Proteus vulgaris*, and *Mycobacterium smegmatis*, but did not show any antagonistic effect against the yeast *Candia albicans* (Dulgar et al., 2002).

Several studies described by us (Barros et al., 2007; Ferreira et al., 2007; Turkoglu et al., 2007) report a correlation between the mushrooms antioxidant activity and their phenolic content. However, none of the existent reports on mushrooms antioxidants composition and antioxidant activity indicated the stage of development of the fruiting bodies selected for the studies.

In recent years, FT-IR spectroscopy has been introduced as a very efficient and non-destructive analytical tool for the reliable way to determine the functional groups of mushrooms compenents.

Fourier transform infrared (FT-IR) spectroscopy is one of the most widely used methods to identify chemical compounds and elucidate chemical structure. FT-IR technique is applied to detect compositional differences between samples on the basis of vibrations of various chemical groups at specific wave lengths of the spectrum (400-4000 $cm^{-1}$). Thus, FT-IR spectroscopy is used as a rapid and accurate method to detect natural compounds in food industry, and is often approached as a simple and fast alternative to other laborious methodologies, with minimum sample preparation.

The literature is mentions researches using FT-IR transform infrared and ultraviolet (UV) spectroscopies coupled with data fusion for discriminationn of *Boletus* mushrooms from seven different geographical area in Yunnan Province (Sen et al., 2019).

In another study, cultivated *Wolfiporia extensa* colleted from six regions in Yunnan Provice of China were analyzed by FT-IR and ultra-fast liquid chromatography (UFLC) in order to invstigate the differences and similarities in different origins and parts (Ly et al., 2016).

The use of the FT-IR technique has also been reported for the analysis of food matrices (Andronie et al., 2016), but literature mentions lots of works that involve the use of this technique and its great potential to be used in a large variety of other research fields (Andronie et al., 2019; Keseru et al., 2016).

In the present study it was investigated a principal components of two type of mushrooms powder using FT-IR technique.

The range of 1800-400 $cm^{-1}$, which exhibited major characteristics of mushroom samples was selected for analysis.

## MATERIALS AND METHODS

In this research, we analyzed different varieties of mushrooms according to the analytical information obtained from dried mushrooms by means of Fourier transform infrared spectroscopy (FT-IR). One common varieties of mushrooms species *Lactarius piperatus* were collected at full maturity harvested from one point (1 - 46.6997° N, 23.5650° E), located in Făget commune, Cluj County, Romania.

Another species of mushrooms, *Agaricus bisporus,* were purchased from the local Romanian market. The mushrooms were washed with tap water and then was dried at $40^0C$ for 24 h. The dried mushrooms samples were crushed using a commercial blender.

The sample from the FT-IR spectrum was obtained from 0.003 g of mushrooms used without further purification. FT-IR spectra were performed in the absorbance whit a Jasco FT-IR-4100 spectrophotometer using KBr pellet technique. The sample was prepared using calcinated potassium bromide as a matrix material and was mixed at a proportion of 3 mg of the sample to 200 mg KBr. Then the mixture was condensed in 15 mm die at a pressure equal to 10 t till 2 min. Measurements were carried out on the infrared scale of 650-4000 $cm^{-1}$ and a spectral resolution was set at 4 $cm^{-1}$ and all spectra were acquired over 256 scans. The spectral data were analyzed using Origin 6.0 software (Figures 1 and 2). These spectra were analyzed by comparing the obtained vibrational bands with those of similar functional groups from the literature.

## RESULTS AND DISCUSSIONS

In this study, FI-IR spectra of two type of mushroom species *Lactarius piperatus* and *Agaricus bisporus* (champignon) were obtained and average spectra are presented in Figures 1 and 2. These spectra can give overall and comprehensive metabolic fingerprints of *Lactarius piperatus* and *Agaricus bisporus* mushrooms.

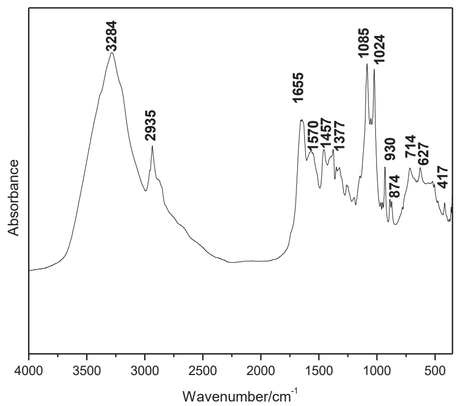


Figure 1. FT-IR spectrum for *Agaricus bisporus* (champignon)

The band at 3284 $cm^{-1}$ which may be caused by strong water absorption mainly represents the O–H stretching (Hirri et al., 2016). The region of 3100-2800 $cm^{-1}$ is mainly related to fatty acids and the obvious absorption peak at 2920 $cm^{-1}$ in this range expresses stretch of methylene group of lipid (Zhao et al., 2015).

The peack present in spectrum characteristic from champinion at 2935 $cm^{-1}$ shows a stretching vibration of the $–CH_3$ group. In addition, a weak peak around 2851 $cm^{-1}$ may be caused by pyranose ring (Mohaček-Grošev et al., 2001).

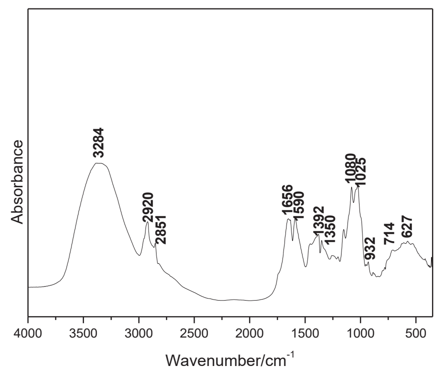


Figure 2. FT-IR spectrum for *Lactarius piperatus*

According to previous literatures, the band of 1700-1000 $cm^{-1}$ is the dominating region which is attributed by organic material in macrofungi (Nie et al., 2007).

Peaks around 1655 $cm^{-1}$ present C=O, C=N and N-H, which may be the result of proteins amide II. Also, the peak around 1570 $cm^{-1}$ and 1590 $cm^{-1}$ can be to protein amide II absorption (Zervakis et al., 2012; Fischer et al., 2006).

The O-H bending and $=CH_2$ groups are present around 1392 $cm^{-1}$ and it belongs to polysaccharides and proteins.

The region of 1720-1480 $cm^{-1}$ is highly relevant to protein substances. Both major peaks around 1085 and 1024 $cm^{-1}$ are assigned to C–C stretching which is attributed as structures of chitin in spectrum of champinion (Nie et al., 2007). This bands appear shifters at 1080 and 1025 $cm^{-1}$ in the spectrum obtained from *Lactarius piperatus* mushrooms whit a lower intensity.

The chitin is the main structural polysaccharide compounds in mushrooms and therefore, the region of 1200-1050 $cm^{-1}$ mainly corresponds to the absorptions of carbohydrate (Mellado-Mojica et al., 2001).

Peaks in the region of 1000-400 $cm^{-1}$ mainly belong to polysaccharides, such as β-D-glucan and pyranose from of glucose. For the above reasons, the characteristic absorption peaks belong to proteins, polysaccharides and amino acids (Sen Yao et al., 2018).

## CONCLUSIONS

FT-IR spectroscopy could provide quantitative information concerning the functional groups of mushroom components.

The vibrational analysis allowed differentiation of mushrooms species according to the protein content.

Analyzing the spectra obtained from the two types of fungi we could notice a decrease in intensity of the bands characteristic of proteins in the case *Lactarius piperatus* mushrooms. This suggests that the *Lactarius piperatus* mushrooms have less protein than they do *Agaricus bisporus*

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