

HEALTH BENEFITS OF *LACTARIOUS DELICIOUS* TYPE MUSHROOM AND ITS USE IN FUNCTIONAL PRODUCTS

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Abstract

In recent years, consumer interest has been increasing to natural products and natural products are taking the place of synthetic products. Mushrooms have been a part of human nutrition and medicine for centuries. They are ideal food with their rich mineral and phytochemical contents, low sugar and fat content. *Lactarius deliciosus*, one of the valuable edible mushroom species, has color characteristics ranging from pale pinkish-yellow to dark orange. It has been stated that *L.deliciosus* has a wide range of biological activities including phenolic, antioxidant, anti-inflammatory, antimicrobial, anti-biofilm, anti-hyperglycemic, immunomodulatory, antiproliferative and anticancer. Mushroom extracts has been used to enrich various food products such as cheese, yoghurt, meat products due to their bioactive properties. The use of *L. deliciosus* mushroom, which is also considered as a prebiotic source, in functional product development is quite limited. The addition of mushroom extracts can stimulate the growth of probiotic bacteria and enable beneficial microorganisms to maintain their viability in the gastrointestinal system. This study aims to examine the possibility of the enrichment of fermented products such as yoghurt and kefir with *L. deliciosus* and the changes in the final products.

Keywords

Lactarius deliciosus, health benefits, phenolic compounds, antioxidant activity, functional products

Introduction

Since ancient times, mushrooms have been part of the human diet and used as medicine. Currently, the mushroom industry is divided into three primary categories: cultivated edible, wild-harvested, and medicinal mushrooms (Robinson *et al.*, 2019). Mushrooms have unique taste, aroma and textural properties as well as unique health-promoting and disease-preventing dietary components. In terms of nutrition, mushrooms have a low calorie, fat, salt, and cholesterol content but are high in proteins, carbs, and dietary fiber (chitin and glucan) (Xiaofen

et al., 2021). Mushrooms are rich in β -glucan, proteoglycan, lectin, phenolic compounds, flavonoids, polysaccharides, triterpenoids, lentinan, schizophylan, lovastatin, pleuran, steroids, glycopeptides, terpenes, saponins, xanones, coumarins, alkaloids, calvacin, nutrients such as flammuvoltoxin and these ingredients show antimicrobial, antiviral, anticancer, antitumor, anti-inflammatory, and immunomodulatory effects (Akyüz and Kırbağ, 2009). They are also an excellent source as they contain bioactive substances and their metabolites with beneficial effects on health (Nowakowski *et al.*, 2021).

Lactarius deliciosus is a type of edible fungus that belongs to the Russulaceae family, which includes some of the most valuable mushrooms in the northern hemisphere. The fungus has characteristics that range from light pinkish yellow to dark orange, and it inhabits tropical, subtropical, and forest environments (Ünal and Karadeniz, 2020). Although it is primarily found in Bulgaria, Spain, Greece, Italy, Cyprus, and France, it also extends into Turkey from Izmir to Antalya. Additionally, in the autumn, it is frequently observed under conifers in the Western Black Sea Region. Among commercialized wild mushroom species in Turkey, saffron milk cap mushrooms (*Lactarius spp.*) are highly well-liked for their aroma, flavor, and attractive look (Adanacıoğlu *et al.*, 2017).

The health benefits of *Lactarius deliciosus*, one of the edible mushroom species, have been reported in various studies. In a study (Erdogan *et al.*, 2017) that compared the antioxidant activity, total phenolic substance, and flavonoid amounts among 12 wild mushroom species collected from different regions in Turkey, it was reported that *L. deliciosus* had the highest values in the first five places. The aim of this review is to present the bioactive compounds and their health benefits of *L. deliciosus* type of mushroom. It also investigates the incorporation of *L. deliciosus* to various fermented dairy products and its effect on the functional and nutritional values of the final products.

Health Benefits of Lactarius Deliciosus Mushroom

As a result of their ideal protein, fat, and carbohydrate ratios, mushrooms are typically regarded as a valuable healthy food. The overall nutritional value of *Lactarius deliciosus* is presented in Table 1. Fresh *L. deliciosus* had a high percentage of moisture and a low dry matter content (8.00%). Carbohydrate was the most abundant ingredient in the dried fruiting body, accounting for 66.61 g per 100 g dw, followed by protein (17.19 g per 100 g dw), ash (8.62 g per 100 g dw), and fat (4.82 per 100 g dw). According to Table 1, consuming *L. deliciosus* is an excellent

way to increase your dietary fiber intake, which can meet low calorie requirements (Xu *et al.*, 2019).

Table 1. Proximate composition, energetic value, dietary fiber, and fat composition of wild *L. delicious* (Xu *et al.*, 2019).

Component	<i>L. delicious</i>
Moisture (g per 100 g)	92.00 ± 0.64
Dry matter (g per 100 g)	8.00 ± 0.64
Total carbohydrate (g per 100 g dw)	66.61 ± 1.02
Crude fat (g per 100 g dw)	4.82 ± 0.15
Crude Protein (g per 100 g dw)	17.19 ± 0.06
Ash (g per 100 g dw)	8.62 ± 0.25
Energy (kcal per 100 g dw)	378.60 ± 2.74
Total dietary fiber (g per 100 g dw)	31.81 ± 1.51
Insoluble dietary fiber (g per 100 g dw)	26.51 ± 1.54
Soluble dietary fiber (g per 100 g dw)	5.30 ± 0.36
C16:0 (% of total fatty acids)	5.17 ± 0.30
C18:0 (% of total fatty acids)	16.96 ± 0.19
C18:1 (% of total fatty acids)	48.37 ± 0.62
C18:2 (% of total fatty acids)	29.49 ± 0.55

Mushrooms exhibit antioxidant properties due to phenolic compounds that scavenge free radicals through electron transfer. Antioxidants present in mushrooms are often phenolic acids and flavonoids (Barros *et al.*, 2007). Total phenolic content (TPC) in aqueous and ethanol extracts from *Lactarius delicious* is shown in Figure 1. *L. delicious* had higher phenolic content in ethanolic extraction than aqueous extraction. It had the highest TPC value among other mushroom species at 95% ethanolic extraction condition (263.7 mg GAE/g) (Nowakowski *et al.*, 2021). However, Xu *et al.*, (2021) reported that TPC of *L. delicious* in aqueous extraction (13.68 ± 0.26 mg GAE/g dw) was higher than in ethanolic extract (4.55 ± 0.24 mg GAE/g dw). It may be related to the regions where *L. delicious* grows.

It is supported by studies (Kosani'c *et al.*, 2016; Tala *et al.*, 2017) that *Lactarius delicious* has a wide range of biological activities, including antioxidant, anti-inflammatory, antimicrobial, anti-hyperglycemic, immunomodulatory, antiproliferative and anticancer (S180 sarcoma, epithelial, human lung and colon cancer). Globally, the incidence of cancer is rising. Glioblastoma is the most prevalent type of adult brain cancer. Anti-glioma mechanisms involved suppressing the growth of cancer cells and reducing the activity of metalloproteinases.

L. delicious found to be one of the fungi with the strongest antiglioma potential (Nowakowski *et al.*, 2021).

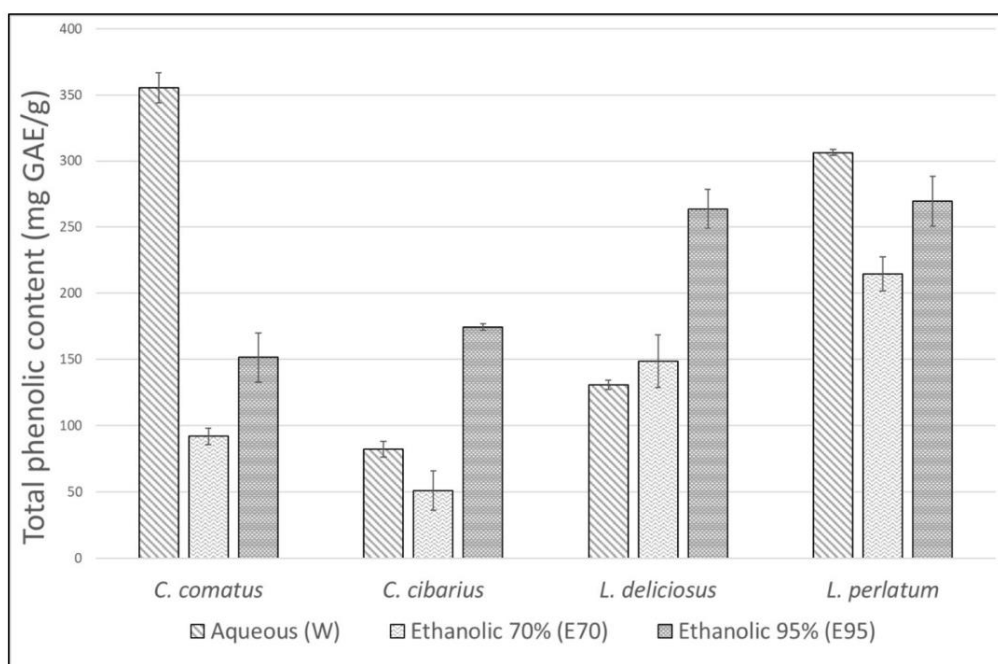


Figure 1. Total phenolic content in aqueous, 70 % ethanol and 95 % ethanol extracts from *Cantharellus cibarius*, *Coprinus comatus*, *Lactarius deliciosus* and *Lycoperdon perlatum* (Nowakowski *et al.*, 2021).

Enrichment of Dairy Products with Lactarius Deliciosus

The most consumed foods in the world include yogurt and other fermented milk products due to their health benefits. In recent years, various fruits and vegetables rich in phenolic compounds have been incorporated to dairy products because milk is relatively poor in antioxidants. In addition to this, they provide to use natural antioxidants in dairy products instead of synthetic ones (Vanegas-Azuero and Gutiérrez, 2018). In this context, mushroom extracts have been added to various dairy products such as cheese and yogurt due to their bioactive properties. For instance, *Schizophyllum commune* mushroom to cheese (Okamura-Matsui *et al.*, 2001), *Agrocy aegerita* mushroom to cream cheese (Petrovic *et al.*, 2015), *Pleurotus ostreatus* and *Lentinus edodes* mushrooms to yogurt (Hozova *et al.*, 2004) and *Pleurotus ostreatus* (Vital *et al.*, 2015) were added to yogurt.

Lactarius deliciosus is a good source of bioactive compounds such as phenolic compounds and dietary fibers. Non-digestible carbohydrates in dietary fibers are sources of prebiotics (Xu *et al.*, 2019). Therefore, *L. deliciosus* as a source of prebiotic can be added to probiotic products

such as yogurt and kefir to produce a synbiotic product. It can provide protection against coronary diseases and regulate the immune system. However, considering the available literature, *L. delicious* has not yet been included in any dairy products. Further research is needed to examine how *L. delicious* affects the physicochemical, microbiological, and sensory qualities of the final products when it is added to different dairy products.

Conclusion

Lactarius deliciosus is a nice wild edible mushroom with a high nutritional value, various phenolic compounds and low calorie content. Future uses for *L. deliciosus* as natural antioxidants and hypoglycemic agents in the food and pharmaceutical industries are also possible. In order to obtain the optimum phenolic compound, *L. deliciosus* should be studied on various extraction techniques. There is no clarity on this subject, some studies have obtained more phenolics in aqueous extraction and some in ethanolic extraction. A useful symbiotic product can be produced by adding *L. deliciosus* extract to various fermented dairy products. It can help to strengthen the immune system and protect gut health.

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