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# What's So Great About Mushrooms

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## Introduction

Mushrooms are getting well-earned recognition these days. People tout their potential to 'save the world' and provide near-miraculous benefits to trees, bees and humans. Make no mistake, in the coming years we will see industries transformed by mushroom products; novel food, fibre, medicinal and other commodities are here with more coming. But in all the excitement it can be hard to distinguish hype from hard fact. Below I highlight a few well-documented examples of emerging mycotechnologies in food, materials, and medicine.

## What are Mushrooms and Fungi

Fungi are organisms made of thread-like cells called hyphae (singular hypha). A bunch of hyphae form mycelium, the cobwebby mass visible in soil or a rotting log. Fungi reproduce by spores that are borne directly on hyphae or on larger structures such as mushrooms and truffles. All mushrooms are fungi, only some fungi make mushrooms.

Fungi are among the most diverse multi-cellular life forms. There are an estimated 60 million species of insects; fungi probably number 1.5 to 6 million species of which perhaps 300,000 are known to science. Of those only 10 to 30,000 make mushrooms. But from those relatively few species come several unique types of crops, medicines and other novel products. About 3000 mushroom species are documented in BC with more being discovered all the time. Species numbers herein refer to Berch and Kroeger[2] recognizing that this is a moving target subject to constant revision as new species are discovered and taxonomic understanding changes.

I present a few examples of 'new' fungal applications out of many available. They were chosen because: they rely on mushroom-producing species with wild local relatives that anyone can learn to find; they are getting a lot of media buzz; or, they may be transformative technology. **Not** included is any of the tremendous research on for fungi in plant health and as biopesticides, to clean contaminated soil and many other applications. So, what follows is the tip of the iceberg–or a sip from the firehose–of new mycological information.

## Emerging Uses

In some sense, none of this is really new. People have eaten mushrooms and used them medicinally and for fiber for thousands of years. Otzi, the 5,000 year old 'iceman' mummy found in the Alps, carried mushrooms for fire-starter and medicine. Our culinary love-affair with mushrooms is ancient but few species are yet cultivated. What is new is the growth and rediscovery of knowledge and the realization that an abundance of new crops and natural products await discovery.

## Food

When it comes to cultivated mushrooms, one species reigns supreme. The button mushroom, champignon, *Agaricus brunnescens* accounts for 99% of mushrooms grown in BC. Other important cultivated species include oyster mushrooms, shiitake, and lion's mane. The opportunity for improving those already in

cultivation and domesticating more kinds is enormous. Cultivated oyster mushroom species include *Pleurotus oystreatus*, *P. populinus*, *P. pulmonarius* and others; for most species of oyster, accurate species ID requires either a mating test or DNA sequencing. Five species of oyster mushrooms occur naturally in BC and in one case a strain isolated locally performed at least as well (and tasted as good!) as commercially available ones.

One impediment to getting oyster mushrooms to market is their short shelf life. Can one breed oyster mushrooms for improved shelf-life, yield and disease resistance? *Pleurotus dryinus*, a local species found on maple trees, is a bit tougher. Could hybrids with this species produce longer-lasting mushrooms while maintaining other desirable characteristics?

Dozens of other more or less easily grown mushrooms including almond agaricus and native relatives of lion's mane, plus countless others with commercial potential, occur in BC (**Table 1**). While plant proteins are great, mushrooms offer amazing diversity of taste and texture and are nutrient dense.

| **Cultivated Species** | **BC Wild Relatives** | **Notes** |
|---|---|---|
| Button mushroom, crimini, portabello; *Agaricus brunnescens* | *Agaricus augustus, A. subrufescens* | 30 BC species, not all edible |
| Chestnut mushroom, Pholiota adiposa | *Pholiota spp.* | 30 BC species, not all edible |
| Enoke, *Flamulina filaformis* | *F. velutipes* | Two BC species |
| Lion's mane *Hericium erinaceus* | *H. abietis*, *H. americanum, H corraloides, H. erinaceus* | Four BC species. Choice edibles, some with demonstrated medicinal value |
| Oyster mushrooms, *Pleurotus oystreatus, P. pulmonarius* | *Pleurotus dryinus*, *P. oystreatus, P. pulmonarius* | Five BC species |
| Pioppini/poplar mushroom, *Agrocybe aegerita* | *Agrocybe praecox* | Eight BC species |
| 'Cubes', *Psilocybe cubensis* | *Psilocybe spp.* | Twenty one BC species |

**Table 1.** A few examples of cultivated mushroom species with wild relatives in British Columbia.

All of the cultivated species mentioned thus far are saprobic, decomposers obtaining nutrition from dead organic material (straw, sawdust, etc.). Another guild of cultivated mushrooms is the truffles, which form symbiotic, mycorrhizal associations with tree roots and produce their fruit underground. Truffles (*Tuber aestivum, T. borchii, T. melanosporum*, etc.) are the only mycorrhizal species thus far commercially cultivated. They are a highly experimental crop in BC requiring properly inoculated trees (usually hazelnut or oak) and intensive soil management for success. Few attempts have yet been made to cultivate the many native truffles of BC. Other mycorrhizal species that are commercially harvested from the wild include boletes (*Boletus* and *Leccinum spp.*), chanterelles (*Cantharellus* and *Craterellus* spp.), hedgehogs (*Hydnum* spp.) and pine mushrooms (*Tricholoma murrillianum*).

We have a long way to go before we'll have chanterelle orchards, but there are many scientists working to tame mycorrhizal mushrooms. In addition, it may be economically viable to manage forests for their mycorrhizal mushroom harvest. In some instances, value of mushrooms harvested is estimated to equal that of timber harvest over a stand rotation. Adding to the value of the harvested mushrooms is potential ecotourism revenue from mushroom-hunting tours.
Among the more mysterious mushrooms, morels may be mycorrhizal or saprobic depending on the species. Morels are highly sought wild mushrooms, efforts at cultivating them are starting to bear fruit both in semi-

natural, outdoor and controlled indoor settings. We have about ten morel species in BC. Some frequently fruit in landscaped areas which makes them likely candidates for cultivation.

**Fibre**

Traditional uses of mushrooms include the making of hats from certain polypores. Mushrooms can also be used to make brilliant, light- fast, dyes for wool and other fibers.

Two emerging uses of mushroom materials are packaging and leather substitutes. These also rely on polypores and relatives, those tough and leathery to woody mushrooms that are often found on logs. Over 200 polypore species occur in BC, a few may be used to make custom-formed biodegradable packing material. Ecovative Design, LLC has such well-known clients for its innovative mycelium based packaging as Dell computers and 3M and raised over $60 million. Mushroom leather has attracted attention from high-end fashion houses like Hermes and one start up company making mushroom leather has obtained a similar amount of investment.

**Medicines**

Mushrooms have a long medical history but until recently this remained the province of traditional/herbal remedies–potentially useful but needing more study. The gold standard for evaluating medical treatments is the double-blind, controlled experiment where neither the patient, nor those administering treatment know whether they are receiving the control or the medicine being tested. A couple of examples highlight the unique potential of mushrooms to treat some fairly intractable conditions.

*Psilocybe* species are called 'magic mushrooms' because they contain the psychedelic compound psilocybin known for its mind-altering properties. Used ceremonially for millennia in Mesoamerica, the introduction of psilocybin and other psychedelics to western culture had such profound and unsettling effects that they were banned and medical research halted by 1966. Among the uses being tested in the 1960's was treatment of addiction. Recently this research has resumed with positive results. In one trial, 10 of 15 people remained abstinent from tobacco for twelve months following one or two guided therapy sessions with psilocybin. Similar trials have demonstrated that psilocybin can reduce anxiety and relieve symptoms of depression.

Worth noting is that psilocybin is only one of at least four related compounds found in some *Psilocybe* species; all of the research focuses on psilocybin. What of the related compounds psilocin, baeocystin and norbaeocystin? There are about twenty *Psilocybe* species known in BC, should we not be giving them greater scrutiny for their medical potential?

A species of *Hericium* called ‘lion's mane’ mushroom has been long touted for aiding mental clarity. It's gaining popularity as a cognitive and memory aid. A recent double-blind trial with fifty participants [total or per group?], all with early symptoms of Alzheimer's, found that daily use of powdered lion’s mane plus an additional amount of erinacine (derived from the same species), for twelve months slowed mental decline compared to those on the placebo. Four *Hericium* species occur in BC, all excellent edibles only one of which (*H. erinaceus*) is cultivated for food and medicine.

**Domestication**

Humans have been domesticating animals, plants and mushrooms for thousands of years. The process begins with selecting individuals from the wild, learning what it takes to grow them, and slowly improving them by selecting for desirable traits such as yield, uniformity and ease of propagation. Domestication is

accelerated with understanding of genetics and breeding but it still takes time and resources to accomplish and is a risky, long-term business endeavor.

Perhaps the most valuable resource for domesticating new species is flourishing wild populations full of genetic diversity and potential, the evolutionary source from which all future generations of the species arise. Every species and individual has unique potential. Variety improvement is a 'numbers game', the more individuals scrutinized, the better chances of finding superior characters. Protecting the habitats, such as ancient forests, which harbor these wild populations is critical to the domestication process and for maintaining species whose benefits have yet to be discovered.

**Conclusions**

As we look at a few examples of mushrooms as food, fibre and medicine a theme recurs. We have numerous species with commercial potential in each example, of which a very few are currently grown. Even those species being exploited are not much improved through selective breeding (yes, you can breed mushrooms!). What new foods, medicines and other goods will come from as yet undiscovered mushrooms?