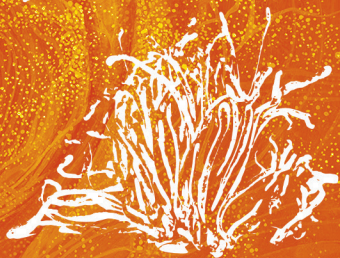


CORDYCEPS MUSHROOM CULTIVATION



**CORDYCEPS
MUSHROOM**

Cultivation
IN THE NORTHEAST UNITED STATES

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MUSHROOM
Cultivation

IN THE NORTHEAST UNITED STATES



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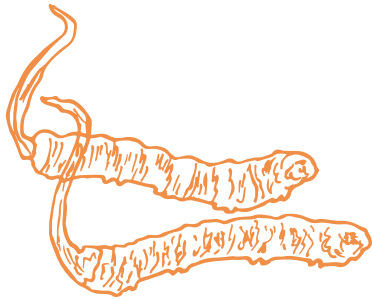


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CORDCYEPS RESEARCH

Cordyceps is a mushroom that is EXPLODING in popularity in the United States for both cultivation and consumption. More and more cordyceps can be found as a supplement in coops and other grocery stores. Social media is filled with people trying to figure out how to cultivate cordyceps. So the team at Fungi Ally decided to take a look and see if we could contribute to the research and information coming out around this mushroom. Over the last year we have looked at how to effectively grow cordyceps on a commercial scale, what the subjective impacts are when we consume cordyceps, and what is behind this explosion of popularity. What we found is summarized below. (Figure 1)

1) Commercial cultivation of Cordyceps is still in its infancy in the United States. With the high cost of labor and current labor intensive methods, cordyceps cannot be commercially cultivated as shiitake or oyster are. Cordyceps can certainly be cultivated by a home grower and some commercial growers that have access to a high value market.

2) Cordyceps is a tasty mushroom that makes a great broth. The broth tastes a lot like chicken bone broth. Completely subjectively, an increase in energy and a brightness in colors after consuming cordyceps was noticed!

3) The excitement around this mushroom is driven by a variety of factors. None of the factors are supported by western scientific research. This doesn't necessarily mean they don't have validity, but should be approached with the understanding that people are formulating opinions based on their own experiences and interests. So, what factors are increasing the consumption and cultivation of this mushroom? As always,



money is a player. Cultivation is increasing because of the potential of cordyceps to be a high-value crop. It is extensively used in supplements, which are all currently coming from China or derived from the mycelium instead of the fruiting body. Wild cordyceps is priced similarly to gold, so the availability of cultivated cordyceps for a relatively affordable price has many people consuming this mushroom. The assumption here is that cordyceps militaris and cordyceps sinensis contain similar compounds and have similar effects in the body. Another factor is the growing popularity of specialty mushrooms in general. More consumers are consuming specialty mushrooms as supplements and looking at them as a source of medicine. Cordyceps has a history of being used and revered for its impacts on the body. Cordyceps is a new mushroom which makes the consumption and cultivation of it exciting. Both growers and consumers that want to be on the cutting edge are exploring this mushroom to become an early adopter.



KINGDOM FUNGI

Cordyceps, like all mushrooms, are located in the kingdom fungi. There are three factors that characterize a fungus. One, the cell walls are made of Chitin. Two, the mode of digestion is absorption. And three, they are heterotrophic. Let's pull these apart one by one. Chitin is a complex, rigid molecule which also comprises lobster and insect shells. Most human stomachs cannot digest Chitin. Since chitin is primarily indigestible when mushrooms are consumed raw, a majority of the nutritional benefits are locked away behind this chitin and unavailable. This is not to say one can eat poisonous mushrooms raw safely! Some compounds in the mushroom are available to our human system without breaking the chitin down but most require the degradation of the chitin before consumption. Chitin can be broken down simply by heat in the process of cooking or making tea or by alcohol in the case of making tinctures.

Through this guidebook we hope to share our experience with cordyceps over the last year. We will share the methods, recipes, and techniques used for cordyceps cultivation. We will share information around the medicinal aspects of cordyceps and products being produced. Lastly, we will discuss where cultivation and consumption might be heading, further research needed, and how to start cultivating cordyceps on your own if you are interested.



The second determining factor of a fungus is their mode of digestion. Fungi are unique from most animals because they do not have stomachs. Fungi secrete enzymes outside of their body, breaking down whatever they are growing in and absorbing the nutrients back into their body. The enzymes that are secreted by fungi are strong compounds that not only break down the food source but also protect the fungus. These enzymes are a cocktail of different antifungals, antibacterials, and probiotics which guide the microbial growth around the mycelial network. Some mushroom species, such as wine cap, require the presence of certain bacteria in order to fruit. The enzymes that are produced can be signals or food sources for certain bacteria to proliferate. One radically different consequence of this method of nutrition is that fungi need to grow on or in their food source. Fungi cannot survive in the mycelial state separate from their food source.



Lastly fungi are heterotrophic, meaning they rely on an external food source. Fungi are not capable of photosynthesizing. Unlike plants they cannot transform the sun's energy into matter. Fungi are the recyclers, the magicians throughout the cycle of life, that transform death into the possibility of life. Decomposition is not the only ecological role fungi play though. Let's go through 3 of the most common ecological roles fungi play.

ECOLOGICAL ROLES OF FUNGI

Typically there are three ecological roles that fungi may play in an ecosystem: parasitic, mycorrhizal and saprophytic.

1. Saprophytes are organisms that consume dead material. These fungi are what eat wood, leaves, manure, corpses. These are the fungi that link death to life, that continue the cycle of nutrient flow on earth. Saprophytes are the typical mushroom cultivated by people. It is much easier to provide a mushroom with dead material and ideal conditions for growth and fruiting than doing the same on a living host. Things like logs and sawdust and wheat bran are very easy to store, handle, and manipulate to create favorable conditions for mushroom growth. *Cordyceps militaris* is a fungus that can be both parasitic and saprophytic making it possible to grow mushroom fruiting bodies even though a living host is not present.

2. Mycorrhizal fungi are a type of fungus that creates a symbiotic relationship with plant roots, “myco” meaning fungi and “rhizal” meaning roots. Simply a fungus associated with roots! These fungi are on over 90% of plant species. Most of the trees we look at in our daily lives have fungi attached to their root system. These fungi play multiple roles in assisting plant health, nutrient access, and communication across individuals. Amazing studies have been done to illustrate how connected ecosystems really are. These mycorrhizal networks literally connect individuals of the same and different species to each other. Mycorrhizae allow the exchange of nutrients, flowing from sick and healthy trees as well as old and young trees. Through these mycorrhizal networks, information is passed regarding different stressors like pests that may be invading an ecosystem. On an individual level mycorrhizal fungi also expand the root system of plants and help access nutrients that are locked in the soil like phosphorus and pockets of water. Mycorrhizal filaments



are much smaller than roots so can penetrate tiny rocks and cracks that are otherwise inaccessible by the plant. In exchange for these nutrients and water plants trade sugars developed during photosynthesis.

3. Parasitic fungi are fungi that attack a living organism. These fungi give the entire fungal kingdom a bad rap because of their perceived negative impact on human systems. Fungal parasites have a huge impact on crop loss in our agricultural systems. The continued use of monocultures and farming techniques that grow weak plants creates breeding grounds for fungal diseases. These diseases spread rapidly during wet periods and easily travel up the entire country over the course of a growing season. Many of these fungi do not create a mushroom but exist simply in the mycelial and spore stages of the fungal life cycle. Many of these fungi have asexual reproduction cycles where they can rapidly create genetically identical spores for further dissemination. There are some mushroom-forming parasites as well. Honey mushroom, an edible which grows abundantly throughout the U.S., chaga, and cordyceps are all examples of this. One network of honey mushrooms, covering a stretch



CORDYCEPS: WHAT ARE WE TALKING ABOUT?

First off if you haven't watched the BBC video on cordyceps, go check that out now! Cordyceps is a genus of mushrooms located in the ascomycota phylum. The latin name breaks down into "cord" and "ceps," meaning "club" and "head." Presumably, a club fungus fruiting out of the head of an insect. The life cycle is radically different than most cultivated mushrooms, which are located in the phylum basidiomycota. Cordyceps have an asexual reproduction stage, which allows them to skip making a fruiting body to produce spores. This is one reason why cultivation of cordyceps can be difficult; not all wild isolates will create fruiting bodies. Strain selection is vital in proper cultivation of cordyceps.

of forest in Oregon that expands 2000 acres in a continuous mycelial mat has been described as the largest organism in the world. Human perception is typically that parasites are a bad thing, but when the largest organism in the world is a parasite, it gives us something to consider, it must be doing something right. Chaga is currently an extremely popular parasitic mushroom which grows on birch trees. Chaga is thought to have a variety of compounds that positively impact the human immune system. Cordyceps is a parasite not of plants or trees but of insects. Cordyceps attack a living insect larvae or pupae, consume it, and then fruit from the dead body of the insect. Some species of Cordyceps can cross over to being saprophytic allowing humans to produce fruiting bodies without the presence of insects.

Cordyceps as a common name typically refers to two species of mushroom, but scientifically it refers to a genus with over 400 species of mushrooms in it. This is the challenge with using common names; most of the time they apply to many different mushrooms. The two primary ones that are typically being referred to when people say "cordyceps" is *Cordyceps sinensis* (renamed in 2007 to be *Ophiocordyceps sinensis*) and *Cordyceps militaris*. There is a lot of debate as to whether these two mushrooms have similar amounts of compounds produced in them and if wild compared to cultivated mushrooms vary widely in compounds. Currently, the prices between the two show that one is valued much higher than the other. The craze for wild cordyceps has allowed prices to balloon with a KG in the US being sold at retail prices of \$50,000! That is around \$22,000 per pound! Now you might understand what this craze for cultivation is about. Amazingly, though, cordyceps militaris grown in China is sold for \$16/lb in the US. Some other common names for *Cordyceps sinensis* are: Caterpillar fungus, yartsa gunbu (translated as "winter worm, summer grass") or **dōng chóng xià cǎo** in Chinese. In this book we will refer to *Cordyceps sinensis* as yartsa gunbu.



of Yartsa Gunbu since the late 1990's has been soaring. Over the ten years between 1998 and 2008 prices increased by 900%. Between 2008 and 2018, prices again increased by that much for larger specimens of Yartsa Gunbu. On average, the price is continuing to increase by 20% every year! Yartsa Gunbu accounts for almost 40% of the income for families in rural Tibet. This mushroom was first written about in a medicinal document written around 1450 in Tibet. In Traditional Chinese Medicine, it first appeared in literature in 1694. The genus of Cordyceps was described by Carl Linnaeus in 1753, but the introduction of Yartsa Gunbu to a western audience has been very recent, around the early 2000's.

Common names for *Cordyceps militaris* have not been developed so we will call it cordyceps in this book. This is part of the confusion around the cultivation and consumption of cordyceps; there is confusion as to what is being talked about when using the word cordyceps. Are we talking about the mushroom that sells for \$22,000/lb or \$16/lb?

YARTSA GUNBU HISTORY

This mushroom has been collected in the Tibetan plateau for centuries. It has only recently become a huge aspect of the economy in that area. Yartsa Gunbu grows on caterpillars in the shrub lands of the Himalayas. The fungus infects the caterpillars in the fall and over the winter consumes the body. During the spring Yartsa Gunbu puts up a fruiting body, which matures into the summer and sporulates in the late summer. The caterpillars in that region shed their skin and are most susceptible to infection during the late summer. Collectors typically go out in May and June to collect this fungus. The economic value



CORDYCEPS MILITARIS HISTORY

Cordyceps *militaris* has been named and renamed since 1753 until it found its current nomenclature in 1818 in Paris. Cordyceps grows throughout Europe and the United States but is more common east of the Rocky Mountains in the U.S. It is a parasitic mushroom that consumes insect larvae and pupae primarily of moths and butterflies. Cultivation of this mushroom has been conducted in Asia much longer than in the United States. It seems cultivation started in the late 90's and really exploded in Asia during the early 2000's. Many Youtube videos and training courses around cultivation of the mushroom have been developed in Thailand, China, Vietnam, and South Korea. William Padilla-Brown, who was the technical advisor for this project and Ryan Gates were some of the first to grow fruiting bodies in the US. This was in late 2015 when they discovered a substrate and strain combination that produced fruiting bodies. Since then, strain and substrate trials have been conducted to find a combination that can produce commercially. William Padilla-Brown also offers courses on cordyceps cultivation. Since early 2016, many other farms and growers in the U.S. have developed an interest in cultivating cordyceps. There are several farms looking to develop methods that allow commercial cultivation of cordyceps, but this is still in the beginning stages. These farms sell cordyceps for very high prices to a niche market or further process the mushrooms into a value-added product.

CORDYCEPS AS MEDICINE

Before diving into the medicinal research of cordyceps, and the important factors to distinguish when using medicinal mushrooms, I want to express my current position around medicinal mushrooms. There is a lot of preliminary research and general excitement around medicinal mushrooms. Much of that



research has not made it to human trials and the objective benefits of mushrooms are far from clear in western science. I believe mushrooms are an extremely powerful medicine, that can heal our mind, body, and spirit. I also know there is a lot of money and misinformation involved in the medicinal mushroom supplement field. I think it is critical for users of medicinal mushrooms to have a relationship with the mushrooms they are consuming. Ultimately, one of the most powerful medicines we can develop is relationship. I was at a workshop that Joe Krawzyck (co-owner of Field and Forest) was teaching and something he said about medicinal mushrooms deeply resonated with me. He said something along the lines of "the only medicine with medicinal mushrooms I know works is doing it, being outside and growing mushrooms". I hear deep wisdom in his viewpoint. To think we can take 3 capsules of medicinal mushrooms a day and be perfectly healthy and happy in our lives is foolish. We need to take responsibility for our health and happiness, build relationships with our medicine, and look to be with and in the land. Taking Joe's outlook, the process of learning and foraging for these medicinal mushrooms (*cordyceps militaris* grows wild throughout the northeast as does chaga, reishi, lions mane,

turkey tail, and many other medicinal mushrooms), the process of cultivating them, of cooking them, processing them, watching them grow, looking at them, and touching them is all part of the healing process. Healing can happen, during all of these activities, regardless of the compounds that are found in the mushroom. I encourage everyone to start building a relationship with these fungal medicines, learn who these mushrooms are, how to cultivate them, listen to them and see what magic unfolds. If you have the time and energy, try making your own chaga tea, or reishi tincture, take a walk in the woods to hunt for cordyceps, inoculate some shiitake logs. Take the time to build a relationship with these fungal beings and it becomes part of the healing process.

There is a long list of potential benefits people can receive from cordyceps including anti-cancer, anti-oxidant, anti-inflammatory and anti-microbial activities. Equally as long, the list of compounds that are active and found in cordyceps include cordycepin, cordycepic acid, adenosine, polysaccharides, vitamins, enzymes. Cordycepin was first isolated in the 1950's and has been studied ever since then. Cordycepin has been shown in numerous studies in the East to be a powerful medicine in a range of applications. Most of these studies have been done either on animals or tissue of humans. Very few human studies have been conducted. One interesting study on mice given extracts of the fruiting body of cordyceps found a significant decrease in fatiguing during exercise. After consuming the extract for two or more weeks, mice showed increased ATP levels and the production of antioxidative enzymes during physical activity. The production of lactic acid and several other compounds decreased, allowing for more time before fatigue showed in the body. This similar study was repeated on 28 human subjects during high intensity exercise. The study found that after three weeks of cordyceps supplementation there was an increase in oxygen consumption and time to exhaustion. As the research and consumer interest in cordyceps grows, hopefully more human trials will be conducted. This will help to clarify if all these perceived benefits have the



same impacts on the human body. It is amazing that this mushroom is fetching such an astronomical price while little to no research has confirmed medicinal benefits to the human body. It seems much of the benefit of cordyceps is inferred or transferred to the human body from other studies. (Figure 12)

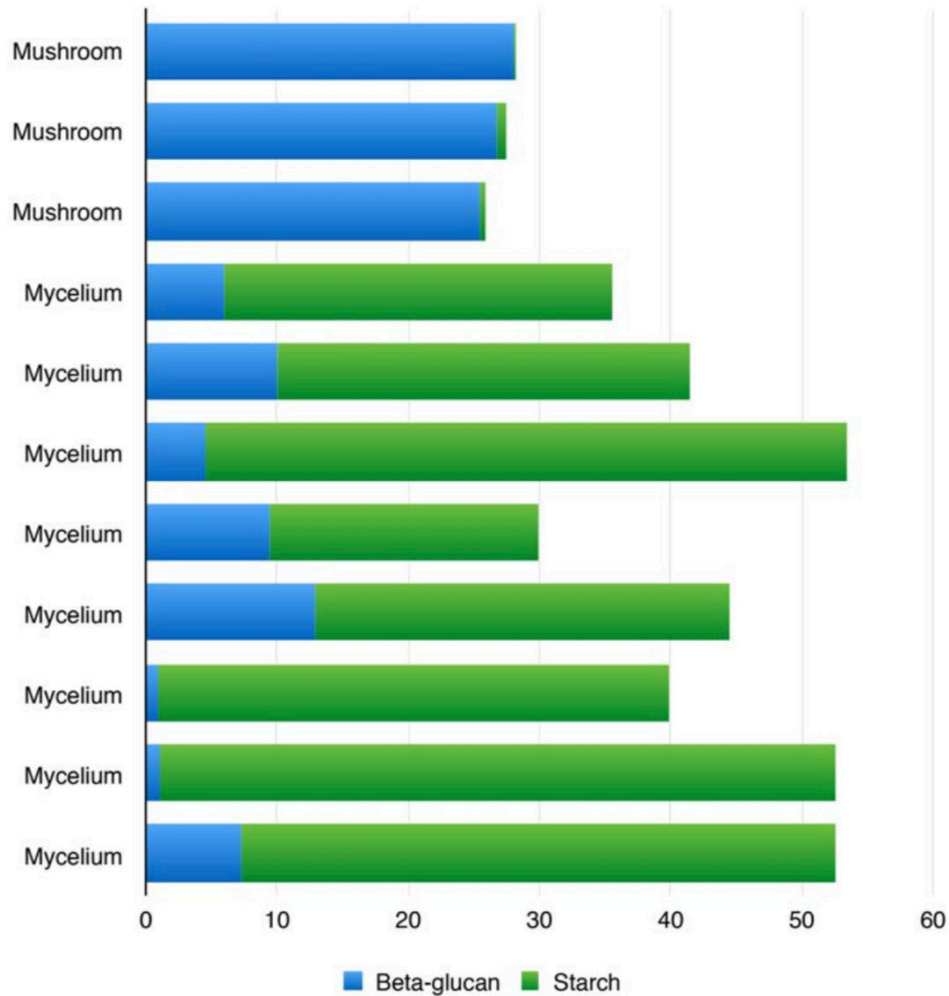
There are three important questions to ask yourself when consuming cordyceps. First, what is actually being consumed: cordyceps or Yartsa Gunbu? Second, is it the fruiting body/mushroom or mycelium that is being consumed? And lastly, if it is mycelium being consumed how was this mycelium grown? Currently, mushroom supplement providers can call their products "mushroom supplements" even if NO mushrooms are in the supplement. Even if it is exclusively mycelium, which is a fungus but not a mushroom, producers can call it a mushroom supplement. This causes a lot of confusion because the medicinal compounds people perceive they are consuming show up in different amounts in these different aspects of the fungal life cycle. Many consumers don't even know what mycelium is but slowly people are understanding the differences between these products.



A mushroom extract product, is the result of fruiting bodies extracted through alcohol and water and then either offered as a liquid or processed into powder form. A mycelial extract is mycelium grown on brown rice and then extracted and freeze dried. The rice is included in these products. When tested, the alpha and beta glucan contents (important indicators of health benefits) between these different products is massive. Historically, most studies have pointed towards beta glucans and polysaccharides as the primary marker of medicinal compounds in mushrooms. The mycelium grown on rice products have large amounts of alpha glucans, or starch, and low amounts of beta glucans, because they still contain the grain on which they were grown. The mushroom extracts are the inverse, containing high amounts of beta glucans but low levels of starch, or alpha glucans. The reasons for using mycelium in a product instead of mushrooms are primarily related to scale and economics, the process being faster, cheaper, and easier to scale up as needed. Mushroom production, on the other hand, takes more time and is more expensive. There is no scientific reason to produce mycelial extracts instead of mushroom extracts. In a 2003 study by Paul Stamets, he confirms fruiting body extracts contain higher beta-glucan content but rice-grown mycelium produces a different constituent family, arabinoxylenes, which have similar impacts on immunomodulatory responses.

Most studies focus on the beta-glucans produced by the mushrooms. Nammex, a mushroom supplement company that sells extracted mushroom powders, ran trials looking at beta- and alpha glucan content between mushroom and mycelium products. Their results were drastic. Below is the first graph, which illustrates 3 mushroom-derived products and 8 mycelium-derived products. This graph compares the alpha- and beta glucan contents of these products.





This second graph shows the difference between 3 different cordyceps products. Fruiting body, mycelium, and finally CS-4 which is a mycelial extract of one strain of Yartsa Gunbu.

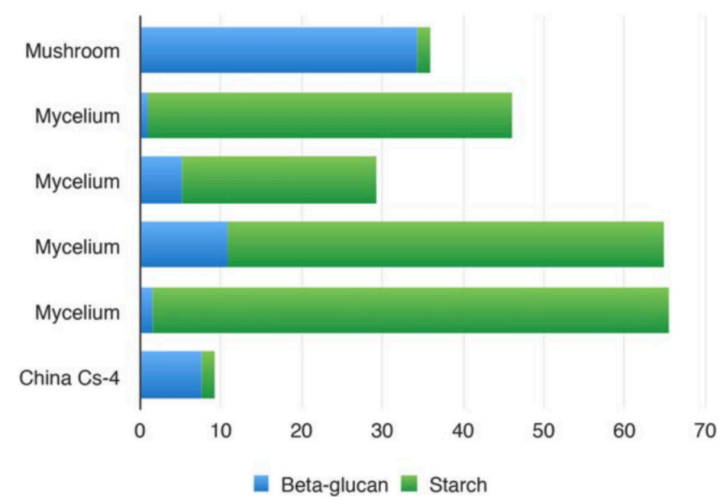


Figure 8. *Cordyceps militaris* fruiting body, Chinese Cs-4 pure mycelium, and four grain-based *Cordyceps* mycelium products. All data expressed as percentage of dry weight.

Both graphs are from the 2017 Nammex white paper written by Jeff Chilton and can be found at <https://www.nammex.com/redefining-medicinal-mushrooms/>. This is a comprehensive publication discussing the difference between mycelium and fruiting body based extracts, as well as the medicinal compounds found in mushrooms.

In summary, there is more to a medicinal mushroom product than meets the eye. Learning both what species and what fungal part is in any product is critical. The mushroom supplement industry is at \$34 billion and is expected to grow to \$70 billion by the end of 2024. This is a lot of money, and that can lead to misleading information and marketing. Hopefully more research will come out on the impacts of mushrooms on the human body and the difference between mycelium and fruiting body products. Consumer education will be vital to continue growing this field in a way that supports the public rather than scamming them.

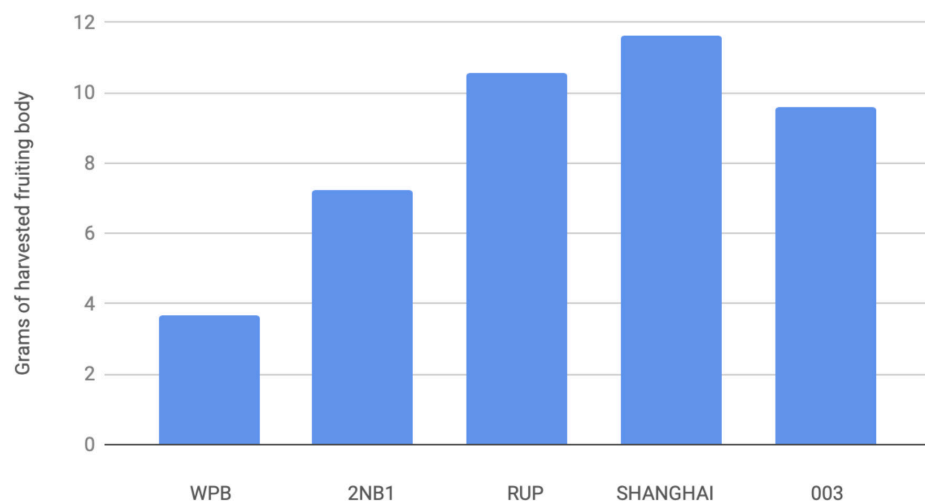
CORDYCEPS CULTIVATION

Cordyceps cultivation is actually an easier method of cultivation than most specialty mushrooms. The difficult parts are finding a strain that will fruit and growing it at a commercial scale. To successfully grow cordyceps for home cultivation is pretty straight forward. It requires only two things: a viable spawn and, ideally, a pressure cooker, though even a normal pot could be used instead. This section will progress based on the seven stages of cultivation laid out in Tradd Cotter's book *Organic Mushroom Farming*. 1) Media preparation 2) Inoculation 3) Spawn run 4) Full colonization 5) Pinning 6) Fruiting 7) Rest. Before media preparation, strain selection and spawn sourcing will be covered. Numbers five through seven will be combined as the fruiting strategy for cordyceps is the same throughout the entire process, and second fruitings are not done on cordyceps substrate.

A) Strain and Spawn

During trials at Fungi Ally, five different strains of cordyceps were cultivated. These five strains were: WPB, 2NB1, RUP, Shanghai, 003

Cordyceps: Average harvest by Jar



Of these, two did the best, both from commercial strains which came from outside of the United States. Many of the U.S.-based strains are wild clones and have not yet been developed or thoroughly tested to produce high yields. Strains grown in Thailand, China, and India have typically been bred to be fast-growing, high-yielding strains. The strain which fruited most abundantly was a clone from Shanghai. The next highest fruiter was from India. These strains also had the most consistent fruiting with all jars from the Shanghai strain fruiting and all but two of the jars from the RUP strain fruiting. Of 33 jars, the WPB strain had 17 that did not fruit but were well colonized, and strain 2NB1 had 11 jars out of 28 that fully colonized but did not fruit. Calculating the average yield without jars that did not fruit had little to no impact on yield averages. The average yield per jar from the Shanghai strain was 11.6 grams. (FIGURE 20) The mushrooms of this strain were very dense and would be a great culinary mushroom. Shanghai or RUP would definitely be the strains I would work with if growing cordyceps. If you would like a plate of the Shanghai strain, email willie@fungially.com. Other companies that

currently offer plates and liquid culture of cordyceps include Asheville Fungi (ashevillefungi.com) and Mycoshop.com (Will Padilla-Brown's company). In Fungi Ally trials, petri plates were expanded directly onto the fruiting media. Several times, we tried to grow 5-pound bags of grain spawn but they did not colonize well. This would be a huge advancement in cordyceps cultivation as spawning rates could be much higher allowing for faster growth and likely higher yields. Liquid culture can be used for cordyceps cultivation as well making the use of a flow hood unnecessary. For more information around liquid culture technique, check out Peter McCoy on Youtube.

B) Media Preparation

Picking a good media recipe is crucial to getting good yields from cordyceps. During all trials we used the formula below, recommended by William Padilla-Brown.

1 gallon water

1/2 cup starch

1/4 cup nutritional yeast

2 tbsp sugar

2 tbsp azomite

5 scoops baby food

This makes 72 pint jars.



Shanghai



003



RUP



WPB



2NB1

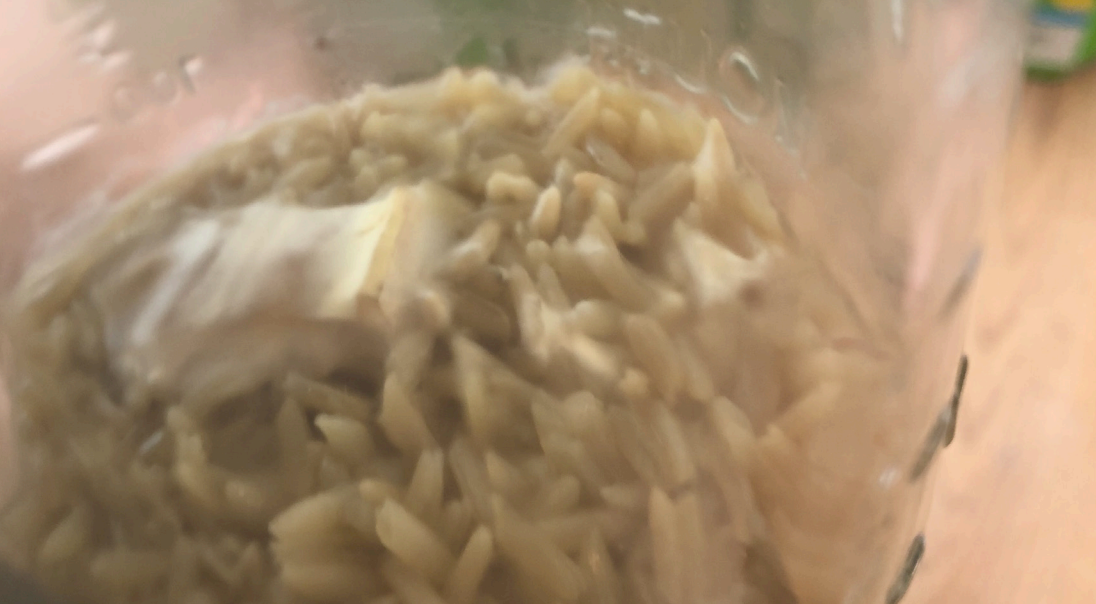
First, 2 TBSP rice was placed in wide-mouth pint jars. Next, all other ingredients were mixed in a large mixing bowl until they were dissolved. Finally, a 1/4 cup of the liquid was poured into each Mason jar. The lid with a polyfill filter is placed on top of the jar and screwed on. The jar is then loaded into the sterilizer. Polyfill is used to stuff many pillows and can be purchased at most big department stores. A hole is punched into the top

of the lid of a jar using a screwdriver and then a ball of the polyfill is pressed into this hole so it is sticking out of both the top and bottom. This acts as a low-budget air filter. (FIGURE 26) Sterilization was done in a 28-quart All American sterilizer. The temperature was brought up to 250 degrees Fahrenheit and maintained for about 3 hours. The cooker was then allowed to cool overnight before inoculation. If attempting to commercialize cordyceps cultivation, another possibility for this step is to use atmospheric steam to treat the media instead of a pressure cooker or autoclave.



The Container

In one set of trials we attempted to develop a new container in which to cultivate cordyceps. We trialed trays, bags, and jars. Both the tray and bags failed to colonize. The bags would be a huge benefit because over 100 can fit into the sterilizer at a time. With jars, only 24 could fit in the sterilizer. Not needing to wash jars would also reduce overall time in the cultivation process. The biggest difficulty was getting the spawn (an agar wedge) in contact with the growing media at the bottom of the bag. Unicorn 10A bags were used, which are 18 inches tall. By using a much shorter custom bag, this problem may be addressed. The trays were all contaminated because of lack of filtration. Other growers in the US and around the world have successfully used tray cultivation and this could be a good route for growers interested in commercial cultivation. In these setups, bread pans are typically covered with aluminum foil and sterilized, the aluminum foil is peeled back slightly to inoculate and then placed back around the pan. The entire pan is then placed into a plastic bag and tied off.



C) Inoculation

Currently, cordyceps spawn is not available through the internet or typical spawn providers. To inoculate, we used wedges from fully grown petri plates. After the bags were cooled overnight, they were moved in front of a flow hood in a positive pressure lab. The flow hood filters all airborne contaminants out so the sterilized media can be safely open and inoculated. Petri plates were cut into 8 pie slices and one slice was placed into each jar. Once the wedge was placed into the jar the top was closed and the jar was moved to incubation.

D) Incubation

Spawn run is very straightforward for cordyceps. The cordyceps mycelium will grow vigorously in the dark at temperatures between 55-75 degrees Fahrenheit. If grain spawn was able to be developed, this incubation time could be minimized, increasing the commercial viability of this crop. Spawn run typically took about 21 days for most strains. Several of the lower-yielding strains took longer but on average, it was a 21 day process until full colonization was complete.

E) Pinning and fruiting

Fruiting is initiated primarily by changing the light cycles. Temperature can play a factor as well, depending on what the incubation temperature was. A 16 hour on and 8 hour off light cycle is ideal for fruiting cordyceps, they are extremely phototropic and will grow towards any source of light. If fruiting on shelving, it is helpful to have lights on each layer. In our trials, regular fluorescent shop lights were used. Temperature should not rise above 80 degrees Fahrenheit as this will fry and kill the fruiting bodies. Ideally, temperatures during fruiting should stay between 60-70 degrees Fahrenheit. The jar is left as is, so oxygen levels and humidity do not need to be monitored or maintained during cordyceps fruiting. (FIGURE 30) This makes cordyceps fruiting especially appealing because a lot of energy is utilized fruiting other specialty mushrooms with exchanging air and maintaining proper humidity levels.



F) Harvest

Fruiting can take anywhere from 4-6 weeks, a very long fruiting cycle for a fleshy mushroom. Luckily, very little maintenance is needed during this time period. Fruiting bodies will continue to grow until they reach the top of jar, but sometimes mushrooms don't get that high. Harvesting should occur when the mushrooms are done growing or reach maximum height in the container. Both the grain medium and fruiting bodies can be harvested and utilized. The grain medium is what most US based medicinal mushroom companies use now. This can be made into a tempeh dish or extracted for any health benefits that can be found in the mycelium/substrate combination. The fruiting bodies can be used fresh for culinary purposes, for example to make delicious broths, or they can be extracted with hot water and alcohol. Cordyceps is not typically fruited for a second time. With the Shanghai strain, jars averaged about 12 grams of fruiting bodies. The average weight of substrate and cordyceps mycelium was 51 grams. If these products were sold for similar prices to the ones cited above or mixed together and sold as some companies do, cordyceps production would be economical on a commercial scale.

SELLING CORDYCEPS

Cordyceps as a supplement is currently a high-value product. US-grown cordyceps fruiting bodies are practically impossible to find. Two online stores that carry them sell them for \$120 and \$100 per dry ounce. In Fungi Ally trials, cordyceps dried to 13% of the fresh weight. This means one dry ounce is about 7.7 fresh ounces. At these prices, fresh cordyceps fruiting body is selling at \$250-210 per pound. At those prices, the mushrooms produced from each jar of the Shanghai strain were worth \$5.72. I think those are unrealistic prices for farmers to expect an average consumer to pay. Maybe businesses with niche markets or that are making value-added products can get that price for a short amount of time, but I expect that will drop significantly over the coming years. Cordyceps mushrooms coming in from China are sold at \$16/lb. If you are interested in consuming cordyceps, maybe this makes it worth it for you to follow this process and cultivate your own.



FURTHER RESEARCH

Below are several things that could be looked into to make cordyceps production viable in the United States. There is potential for this mushroom to become common place on U.S. specialty mushroom farms, but a few more advances are needed.

- 1 Growing in trays
- 2 Treating media with atmospheric steam
- 3 Studying in China, Thailand, South Korea on cultivation techniques there, as large scale commercial operations currently exist.
- 4 Developing grain spawn for cordyceps
- 5 Market analysis for cordyceps fruiting body as a supplement or food
- 6 The different compounds and quantities of compounds between fruiting bodies and mycelium grown on rice.



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