



Making Medicine with Medicinal Mushrooms

Dr. Anna Sitkoff, ND

Table of Contents

Methods	Page #
Polysaccharides	4
Volatile compounds and triterpenes	5
Fatty acids	7
Phenolic compounds	8
Triple extraction	8
Concentrated tar	9
Powdered mushroom extract	11
Mushrooms and skin care	12
Body butter	13

Take a moment to forget.

Forget about the idea that mushrooms have chemicals that have pharmacological potential. Forget that you want to learn about the mushrooms so that you can 'use' them.

Just for a moment, let's see the mushrooms as their own organism.

Their own organism with all of their chemicals not for the human system, but for the fungal system.

Every constituent that we wish to extract and isolate and identify has an important role within the living mushroom, and a role within the entire ecosystem.

Let's explore these compounds and their functions within the mushroom before exploring their functions and relations within the human system.

Remember, a human is not their cholesterol, a human is not their pheromones, a human is not their amino acids. A human is a synergistic organism made up of thousands of molecules and cells all working together. It is impossible to understand who a human is from just analyzing one of these molecules.

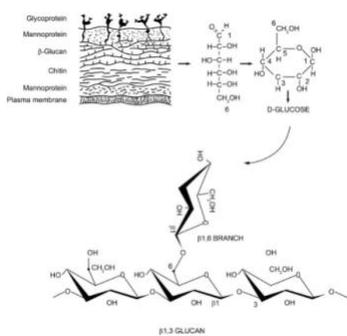
When we look at the mushroom through the lens of its parts, keep in mind it is the synergism between these parts that makes the organism, not the isolated constituents.

The Fungal Cell

The cell wall is an exquisite and imperative structure in all organisms. The cell wall role in fungi is similar to the role of the cell membrane in humans – it is dynamic in controlling the shape and protecting the organism from the environment. The cell wall is made up of compounds involved in morphogenesis, reproduction, cell-cell and cell-matrix interaction. The fungal cell is rigid as it is made up of one of the hardest substances, chitin. Although rigid, it must also be complex to allow for budding, growth and adaptation to environmental stress. The fungal cell wall is composed of multidimensional, communicating polysaccharides including chitin and glucans.

Polysaccharides

- Many simple sugar molecules attached to one another, referred to as glucans when it is glucose molecules-



In the Mushroom

These chains of sugars may be extracellular (outside the cell wall), may be associated with the cell wall and membrane, or may be intracellular. Extracellular polysaccharide function is unclear, pullulan a polysaccharide similar to glycogen and mycodextran are alpha linked glucans that are extracellular. From what I could gather, the function of these may be as storage reserves. Beta 1,3 and beta 1,6 glucans are also sometimes found on the outside of the cell, but are most often important components of the cell wall itself. The major role of polysaccharides is in providing cell wall structure. As Basidiomycota (fungi with fruiting bodies) grow and mature fruiting bodies, the total polysaccharide levels increase.

With this knowledge about the role of these compounds as structural support and barrier to the fungal cell we can understand the role within the human organism.

In the Human

The polysaccharides act in the human in an analogous way as they act in the fungal cell. They support the human cells in responding to environmental stressors within the human terrain.

Polysaccharides play a number of functions in the human system. Once ingested, these compounds move through the GI, coming into contact to mucous membranes all the way down

through the inner tube from mouth to anus. The mucous membranes have lymphoid tissue called gut associated lymphoid tissue (GALT) that contains immune cells called macrophages. These macrophages, or big eaters, are an important part of our innate immune system. These immune cells have specific receptors for beta-glucans, Dectin-1 and TLR2. Once the beta- glucans come into contact with them, there are chemical messengers called cytokines that are stimulated. Specifically, IL-12 and IFN- γ . These cytokines are important in stimulating Natural killer cells, Cytotoxic T cells and TH1 cells. Once these cells are stimulated they target viruses and cancer cells.

Polysaccharides also function as soluble fiber. When they enter the gut, they slow the release of glucose into the blood stream, acting as hypoglycemic compounds. They also help to decrease cholesterol through binding bile acids. When bile acids end up in the soluble fiber, they are pooped out and then the body will use cholesterol to make more, rather than recycling the bile acids. Along with binding bile acids, they also prevent absorption of cholesterol from food in the GI, further lowering serum cholesterol. These polysaccharides are also beneficial in controlling blood sugar. Polysaccharides inhibit the enzyme, alpha-glucosidase, this enzyme is known to induce after meal hyperglycemia. Along with inhibiting this enzyme, polysaccharides have also been shown to upregulate the GLUT 4, insulin-response glucose transporter, while down regulating NFkappa-B, a nuclear transcription factor that controls regulation of inflammation.

Polysaccharides as antioxidants: Polysaccharides increase activities of liver oxidative enzymes, catalase, glutathione peroxidase, and superoxide dismutase and increase glutathione and malondialdehyde levels. This is all to say that these compounds support our innate antioxidant systems supporting the human in relieving oxidative stress and free radical damage.

Polysaccharides as prebiotics: The oligosaccharides and polysaccharides contained in mushrooms are consumed by Bifidobacterium and Lactobacilli, two important bacteria in a healthy microbiome. Through supporting a healthy gut microbiome, this can also be helpful with asthma, allergies, anxiety and even depression.

Extraction method:

Hot water – 100 degrees C for at least 2 hours

Volatiles Compounds and Triterpenes

Low molecular weight, carbon-based compounds that vaporize at about 20 degrees Celsius.
Include: Alcohols, monoterpenes, sesquiterpenes, aldehydes, and ketones

Triterpenes have 30 carbons and are too heavy to be volatile, but I put them here since they are made in the same pathway as monoterpenes and sesquiterpenes.

In the Mushroom

These volatile compounds are derived from primary and secondary metabolism pathways; they diffuse through the atmosphere as "info-chemicals"

These chemicals function as attractants and deterrents to insects and other invertebrates. Fungal volatiles have important properties as pheromones and defense. Some of these compounds are an efficient way of defending against fungal feeders. Octanol, often called mushroom alcohol, is an alcohol that deters banana slugs from eating mushrooms while also serving as an attractant for fungus eating beetles. Amusingly, octanol from human skin serves as a host odor cue that attracts blood sucking insects. *Trametes versicolor* is an example of a polypore mushroom that produces sesquiterpenes: specifically, cardinene, beta guaene, isodene and gamma patchoulene that attract fungivorous beetles. Through attracting these insects the mushrooms are better able to spread their spores and inoculate nearby substrate. A good way to make more of themselves!

Monoterpenes, sesquiterpenes and triterpenes are all compounds in mushrooms that have a cholesterol backbone. (The chemical structure looks similar to cholesterol)

Triterpenes are the heaviest of the three since they have 30 carbons and the others have 10 and 15 carbons respectively. Within the mushroom cell, triterpenes are converted into various metabolites including sterols, steroids, and saponins. They are produced via a pathway called the mevalonate pathway with a starting molecule called acetyl-CoA. Animals have a very similar pathway that leads to cholesterol synthesis! This pathway in fungi also leads to ergosterol (a precursor to vitamin D2) which plays the same role that cholesterol plays in the human cell. It is a major component of the plasma cell membrane in fungi, important for membrane permeability.

Cytochrome p450 is important in gene expression and triterpenoid production. There is significantly more CYP450 during the transition from primordia to fruiting bodies, correlating with a higher triterpene content in the mushroom fruiting bodies. – developmental stage of fungal growth plays an important role in the regulation of secondary metabolite genes.

In the Human

Volatile compounds are very low molecular weight and cross easily through barriers and membranes. It is for this reason that essential oils are so readily absorbed through the skin and mucous membranes. Some volatile compounds can be neurotoxic for this reason, and some can be neuroprotective. There is research now exploring the role of octanol as an antiseizure agent. Octanol reduced seizure induction and seizure discharges when it was applied directly to the epileptic focus in the somatosensory cortex. Additionally, it has been reported that administration of octanol significantly reduces the frequency and amplitude of epileptiform spikes, as well as the epileptic behavioral score induced by the administration of penicillin.

Some fungal sesquiterpenes have also been shown to inhibit TGF- β , decreasing kidney fibrosis in late stage kidney disease. Triterpenes are major compounds of interest in cancer research. Triterpenes have been shown to be directly cytotoxic to many cancer cell lines. Triterpenes also have specific antiviral activity, inhibiting an enzyme, neuraminidase, which is important for viruses to be able to leave one cell to enter another. Triterpene compounds have been shown to be very beneficial in treatment of hypersensitivity reactions. Hypersensitivity reactions include allergy, asthma, dermatitis, and rhinitis. Triterpenes inhibit histamine release from mast cells – less histamine will result in less of a reaction. These can also be used in treatment of inflammatory reactions caused by insect stings and bites.

Extraction Method

Volatile compounds need to be extracted from fresh mushrooms and will escape into the atmosphere with heat. They are alcohol and fat soluble. Best to do a cold ethanol extraction for volatile compounds. 24 hours is sufficient.

Triterpenes will not volatilize and are also fat and alcohol soluble. There are terpenes within the cell, and so it is best to break the chitin cell wall first with a water decoction, before proceeding with ethanol to extract the triterpenes. A triple extraction method will be provided at the end of this post.

Fatty acids

- Molecules that are long chains of lipid-carboxylic *acid* found in fats and oils and in cell membranes as a component of phospholipids and glycolipids -

In the Mushroom

Principal lipids in mushrooms are palmitic and linoleic acid. The fruiting body and pileus (cap) contains more linoleic acid and the stipe contains for oleic acid. The linoleic acid plays a role in fungal reproductive mechanisms. *Trametes versicolor* contains more short chain fatty acids – octanoic, decanoic and lauric acid. Fungal membranes contain large quantities of free fatty acids, specifically glycerolipids and acylglycerols. These fatty acids occur in fungi as the major constituents of oil droplets suspended in mycelial and spore cytoplasm. They are also minor constituents of membranes and cell walls. Their primary function is storage material. Phosphoglycerides are formed from a combination of fatty acids and are found primarily in the plasma membrane of cellular organelles, where they occur as complexes with proteins.

In the Human

Short chain fatty acids found in *Trametes* species modifies human fecal microbiota composition, increasing healthy bacteria - *Bifidobacteria* and *Lactobacillus* while decreasing *E.coli*. Short chain fatty acids also lower the intestinal pH, inhibiting growth of microbial pathogens

These fatty acid compounds also have antioxidant activities found to be as effective as alpha-tocopherol (Vit E) while also showing significant antimicrobial and anti-fungal activity.

Extraction method:

Fat and alcohol soluble

Phenolic compounds

-The term 'phenolic' or 'polyphenol' can be defined chemically as a substance which possesses an aromatic ring bearing one or more hydroxy substituents, including functional derivatives (esters, methyl ethers, glycosides etc.)- Commonly known phenolic compounds include: bioflavonoids and proanthocyanidins

In the Mushroom

The phenolic compounds in mushrooms are secondary metabolites derived from intermediates of the shikimic acid pathway, the primary role of which is to provide the essential aromatic amino acids phenylalanine, tyrosine and tryptophan. The intermediates of the shikimic acid pathway are precursors of aromatic compounds, including phenolic compounds. The biosynthesis of these compounds has demonstrated that they possess enzymes such as ammonia-lyases that convert phenylalanine and tyrosine to cinnamic acids. These compounds represent the building blocks for pigments in mushrooms. The phenolic compound hispolon is an example of a yellow pigment in mushrooms. (Velisek)

In the Human

Phenolic compounds act as powerful antioxidants in the human organism. These compounds help to reduce oxidative stress through their own free radical scavenging activity as well as through stimulating the innate human antioxidant systems. Phenolic compounds in mushrooms have also been shown to inhibit alpha-glucosidase in rats and significantly help with diabetic complications caused by this compound. A specific phenolic compound, hispolon, found in *Phellinus* species has been shown to have analgesic and anti-inflammatory effects as well as inhibits the growth of human cancer cells via the inhibition of the cytokine, TGF-beta. Hispolon also activates caspase, an important enzyme that induces cancer cell death.

Extraction Method:

Ethanol or Water depending on how polar the phenolic compound is, best to do a triple extraction so you are sure to get them all.

The Triple Extraction

The best way to get all of these compounds in one extract is to do a triple extraction method. The first part of the triple extraction is an overnight ethanol extraction. I use 95% ETOH and pour it over finely chopped/shredded fresh mushroom. Let this sit for 24-48 hours. Press the ETOH from the mushroom material and set aside (ETOH extract #1). Next, place the mushrooms from the original extraction into a crockpot or soup pot, cover with water and simmer for 2-12 hrs (The aqueous extract). Next, place these mushrooms and aqueous extract into a jar and leave the jar 1/3 empty. Fill the last 1/3 of the jar with the ETOH extract #1. Let sit (macerate) for a few weeks, shaking and loving daily. Press out mushrooms (the marc) from ETOH/Aqueous solvent (menstruum). Now you have your triple extraction - containing the volatile compounds, the polysaccharides, the triterpenes, phenolic compounds, and fatty acids.

Creating a concentrated tar

- with a dose of just a mL- potent, shelf-stable, alcohol free medicine-

A 5:1 concentrated extract or sometimes called a solid extract simply means there is an equivalent of 5 grams of original substance per 1 mL of final liquid extract

I love these concentrated mushroom extracts, yet it is important to note that these do not replace dual (aqueous and ethanolic) extracts. In the process I will describe below, lipophilic constituents like Triterpenes will likely not occur in the final concentrate.

What will be extracted:

Water soluble constituents that are not destroyed by heat. In the case of mushrooms, specifically *Fomitopsis pinicola*, *Trametes versicolor*, and *Ganoderma applanatum*, which are the mushrooms in this extract, we are extracting; immune-stimulating, immune-modulating, hypoglycemic, and hypocholesterolemic polysaccharides and anti-oxidant phenolic compounds.

What you will need for this preparation:

Mushrooms: at least 300g

Water: enough to cover the mushrooms by a few inches

Crockpot or soup pot

Stove top or hot plate

Beaker to measure mL of liquid

Honey - enough to equal the final amount of liquid in the extract - if starting with 300g of mushrooms, and we are aiming for a 10:1 extract, we need 30mL honey to add, to get a 5:1.

Instructions:

1. Collect mushrooms or purchase dried mushrooms from your local herb shop, slice thin and dry over night
2. Get the dry weight of the mushrooms in grams, then place mushrooms in crockpot or large soup pot and cover with water - so water covers by a few inches
3. let Simmer for a minimum of 2 hours, if using a crockpot it is great to simmer overnight
4. Press out mushrooms from decoction - compost mushrooms, or pour 100 proof vodka over them to extract triterpenes. - if you do this let it mushrooms macerate in ETOH for 2 weeks

5. Place aqueous extract (decocted liquid) in smaller soup pot and let simmer - this is where you want to keep a close eye on the process, stirring somewhere in between occasionally to avoid over simmering and burning
6. Simmer down until there is 30mL of extract (if you started with 300g) - the idea is that you have an equivalent of 10g dried mushroom material for every 1mL liquid. - 10:1
7. Take off the heat and add an equal amount of honey - if there is 30mL of extract, you will add 30mL of raw honey and mix thoroughly, now you have a 5:1 concentrated syrup.

Place in amber jars - Refrigeration is unnecessary-

Powdered Mushroom Extract

Why make a powdered mushroom extract?

This preparation makes it possible to get all the benefits of a mushroom dual extract, and doesn't involve any alcohol. The initial boiling of the mushroom material breaks down the tough chitin cell wall and extracts the polysaccharides. The water is boiled down until there is a thick mushroom slurry. This slurry contains the polysaccharides, high molecular weight terpenes (still in the mushroom material itself), minerals, and sterols (still in the mushroom material). Since the water is extracting only limited amounts of the **triterpene glycosides*** and negligible amounts of other hydrophobic compounds, it is essential we consume the entirety of this slurry. Water can extract the polysaccharides and minerals, while the human body is an excellent solvent, and can take care of the rest. After dehydrating this slurry and following up with a grind, there is a powdery extract that is easy to add to oatmeal, coffee, soup, honey, tea, and anything else you desire mushroom extract in. This powdered extract can also be encapsulated.

***Triterpenes** are common secondary metabolite compounds in medicinal mushrooms. Research shows that these compounds have cytotoxic effects on many cancer cell lines, they are anti-inflammatory, hepato-protective, anti-allergic, and anti-viral.^{1,2,3,4,5,6,7,8}

Things to acquire:

1. A mushroom fruiting body; Turkey Tail, Artist Conk, Reishi, Red Belted Polypore, Willow Bracket, Lion's Mane, etc.
2. Sharp knife for chopping
3. A pot to boil in
4. High speed blender
5. Dehydrator or oven

Directions:

1. Chop freshly harvested mushroom fruiting body
2. Further grind fruiting body in blender
3. Dehydrate over night
4. Place in pot and cover with water
5. Boil down until there is a thick mushroom slurry
6. Place slurry on dehydrator tray (or oven tray)
7. Dehydrate 12-24 hrs at 110 degrees F (if using oven - use lowest setting possible)
8. Grind down in high speed blender
9. If you desire a less fibrous extract, sift further for a finer powder

Using PNW Mushrooms in Skin Care

Fruiting bodies protrude from their hosts throughout our forests, the Ganodermas are a sight to behold and entirely hard to ignore. Ganoderma in itself means "shiny skin" of course referring to the varnished crust on many of the species in this genus, but how can we not apply this to our own, human skin. Following is research that has been done on *Ganoderma lucidum*, *Ganoderma tsugae*, and *Tremella fuciformis* and their uses in skin care. I am postulating that we can use out Northwest analogs, *Ganoderma applanatum*, *Ganoderma oregonense*, and *Tremella mesenterica*, the same way.

Sacchachitin and Polysaccharides for Wound healing

There is a product made, called Sacchachitin that is used as a wound dressing. It is made from the pulp of the Ganoderma fruiting body and when used, significantly speeds up the healing process of skin wounds. (Hung 2004) This product of course is not manufacturable by the general public, yet it is easy enough to chop up the Ganoderma into small pieces, place in a blender with a little water and create a pulp that is then simmered for about an hour. The simmering is not necessary for a styptic effect, but you want to extract the polysaccharides to see anti-inflammatory, antioxidant and increased healing time effects. Speed of wound healing was also observed when Ganoderma polysaccharides were applied to the wounds of diabetic mice. It was observed that the polysaccharides accelerated the wound healing my inhibition of mitochondrial oxidative stress and improved wound angiogenesis (Tie 2012).

Healing from UVB damage

Tremella fuciformis has been used in skin care in Asia for decades, yet there is little research on our local species of Tremella, *Tremella mesenterica*. The polysaccharide content is comparable and so I am using the research and traditional uses of *Tremella fuciformis* as being analogous to the potential uses of *Tremella mesenterica*. Tremella is known to be a potent antioxidant and anti-inflammatory fungus. The Tremella polysaccharide extract was tested on hydrogen peroxide-induced injury of human skin fibroblasts. The polysaccharides from Tremella reduced oxidative stress and cell apoptosis in the treated skin. It also protected the skin fibroblasts from oxidative stress. Oxidative stress is one main reason our skin becomes wrinkled as we age, so using these polysaccharides topically could be beneficial in protecting our skin from wrinkles. The Polysaccharides, which make up about 90% of this species of mushroom, also assist the skin in its ability to retain moisture, an ability that decreases as we age. Tremella polysaccharides have also been researched for lightening skin spots in sun damaged skin and have been shown to inhibit melanin formation. Another study explored Ganoderma polysaccharides and determined that these compounds protect against "photo-aging" by eliminating UVB-induced reactive oxygen species. One local Ganoderma to the PNW is *Ganoderma oregonense*, an analog to the *Ganoderma Tsugae* of the Eastern states. In one study, lanostane terpenoids extracted from *Ganoderma tsugae* fruiting bodies protected human keratinocytes from photodamage.

Triterpenoids and Polysaccharides for Atopic Dermatitis

Atopic dermatitis is a type 1 hypersensitivity reaction, which means it is an IgE mediated immediate hypersensitivity reaction, like an immediate allergic response. Researches explored a beta-glucan based cream for mild to moderate atopic dermatitis. Topical application resulted in significant improvement. In this study, the people with dermatitis put the cream on half their body, and nothing on the other half. The half of their body that the cream was applied to showed significant decline in dermatitis. This benefit would come from the water-soluble constituents of the mushrooms, while another study looked at the lipophilic triterpenes for type 1 hypersensitivity reactions. They found that the triterpene extract inhibited histamine release from rat mast cells induced by IgE. This is a great example where a cream made from both the water and oil extract of the mushroom could be extremely beneficial for these skin conditions. Another example of a type 1 hypersensitivity reaction is the inflammation and itch that we get in response to mosquito bites. A study looked at the methanol extract of *Ganoderma lucidum* and the response of mosquito bitten mice. Results proved the mushroom extract to calm the scratching response of the mice.

Body Butter Recipe

This body butter is a host and fungi preparation. What this means is that the materials used are derived from both the host tree, *Pseudotsuga menziesii* (Doug Fir), and the mushrooms found inhabiting this tree, *Ganoderma applanatum* (Artist Conk) and *Tremella mesenterica* (Witch's butter). The more I delve into mushroom medicine, the more I find it is important to use the tree and mushroom together in formula. So much of the energetic properties and physical properties of the mushrooms are determined by their host tree. These trees have provided oxygen, habitat and strength throughout their lifetimes in the forest and this wisdom flows through the mycelial like veins and into the mushroom fruiting body, that has now come to assist this edifice of the forest in breaking down and returning to the soil.

Materials:

- 1/2 C Ganoderma infused oil*
- Doug Fir Pitch oil**
- 1Tbs cacao butter
- 1Tbs Shea butter
- 1/3oz beeswax
- 1tsp lanolin
- 1/4 C *Ganoderma applanatum* hydrosol or hot water extract
- 1/4 C *Pseudotsuga menziesii* hydrosol or hot water extract
- 1 small piece of fresh, rehydrated or powdered extract of *Tremella mesenterica*
- 10-20 drops Doug Fir essential oil

Instruction:

- Using the double boiler method, add Shea butter, Cacao butter, Ganoderma oil, Doug Fir pitch oil, and beeswax to the top bowl and melt together, stirring every so often.
- In a separate jar mix the hydrosols or water extracts (make sure the extracts are at room temp if recently made. It is a good idea to make them ahead of time and keep refrigerated)
- Add the Tremella piece to the mixed water solution and blend with an immersion blender until well combined.
- When all the oils have melted together with the beeswax, add the lanolin (optional) and slowly pour into the jar full of the aqueous material and blend with immersion blender. After well blended, add the essential oils and blend some more. The final product should be very creamy and will become thicker after it cools off.

*Ganoderma infused oil is made by chopping up any Ganoderma species into the finest pieces possible and covering with oil, I used jojoba oil, but you can use olive oil. This is then left to sit for a few months, or I have been placing it in my dehydrator at 115 degrees F for about a week, the heat will speed up the extraction process.

**Doug Fir pitch oil is made by collecting pitch (sap/resin) from the trees and placing in a sacrificial crockpot, and covering with a small amount of oil until it is just barely covered. Let this warm for many days, strain out and you are left with a beautiful thick resinous oil.

All information from this booklet is cited on my website: Reishiandroses.com