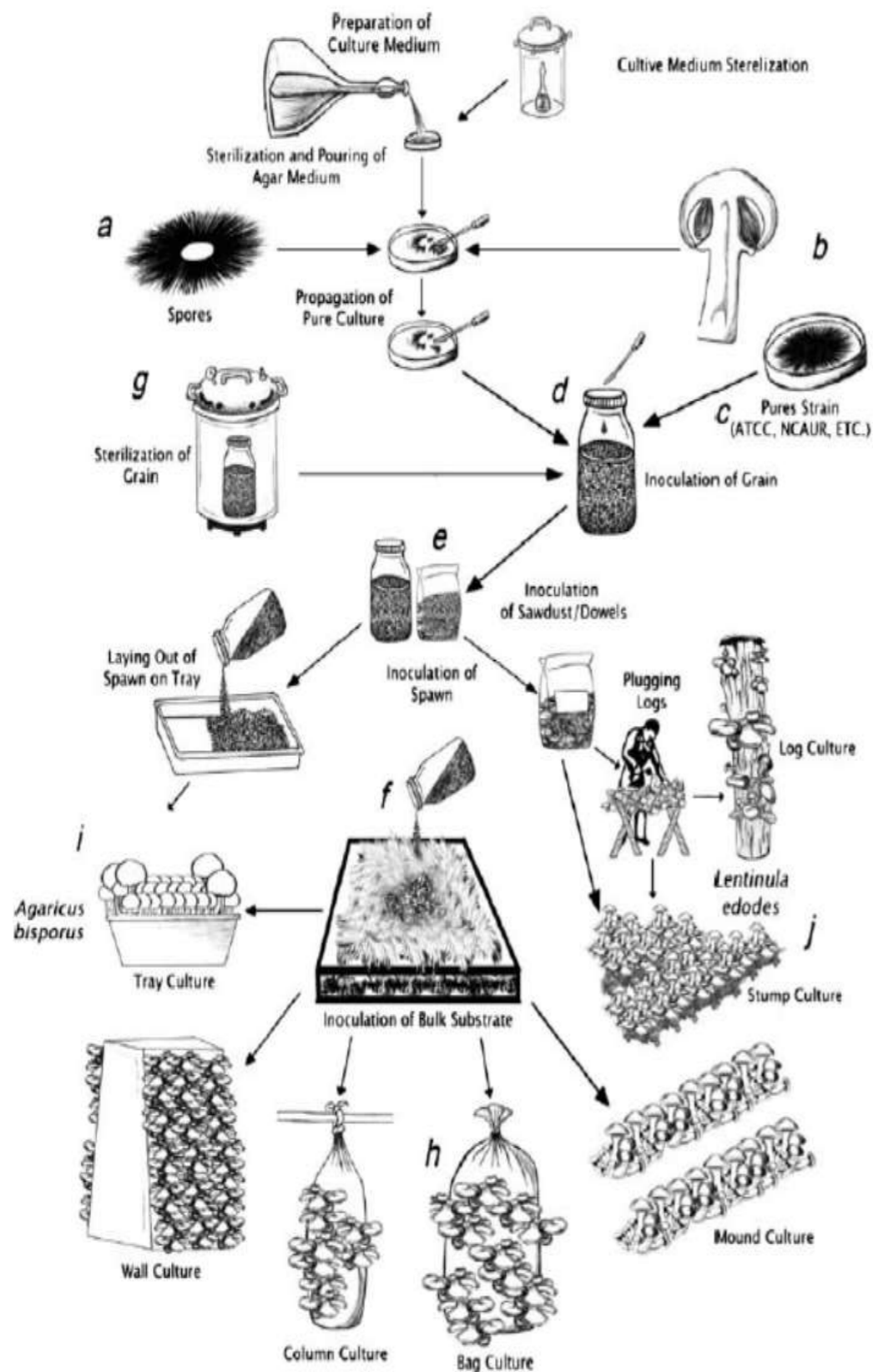


Substrates: Feeding your Mushrooms



The Full Process



- Prepare cultures (7-10 d)

- Spawn production (10-14 d)

- **Substrate preparation** (2-4 d)

- Spawn run (14-21 d)

- Production flush (7-42 d)

Substrate Preparation

Substrate is the material upon which the mycelium of the mushroom grows.



The mycelium digests the material and converts it to energy, allowing the mycelium to expand.



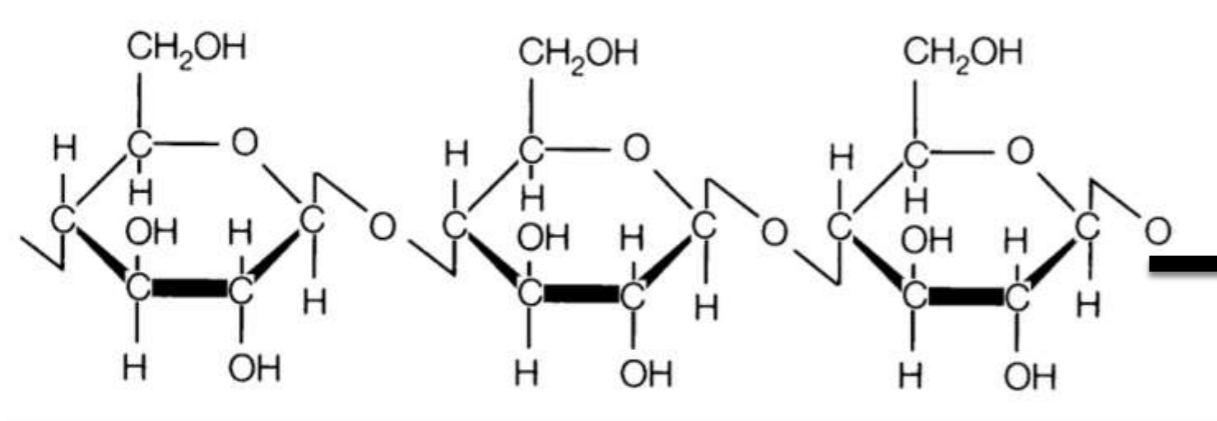
Strands of the mycelium, called *hyphae*, colonize the substrate and absorb nutrients from it.

What is the **Mycelium** Doing?

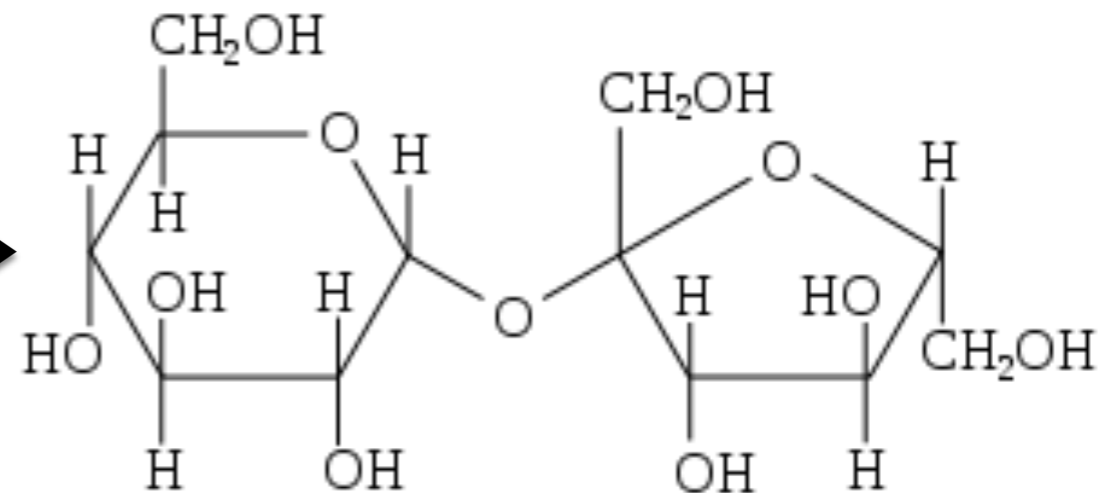


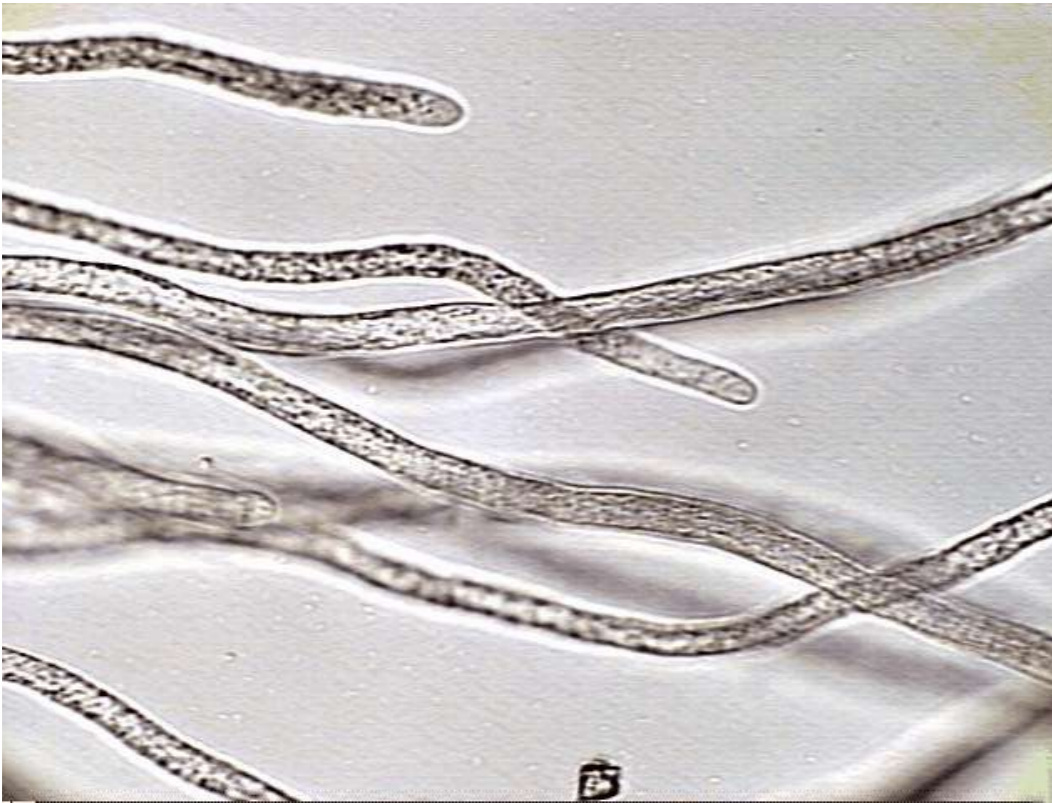
Using a combination of enzymes and physical pressure, hyphae penetrate the substrate and break down polymers (large, complex molecules) into simpler, more easily transportable nutrients.¹

Complex Polymer (Cellulose)



Simple Sugar





These simplified molecules move through the hyphae through diffusion and active transport.

The fungus then uses these nutrients to expand the surface area of the mycelium and to eventually produce its reproductive body, the mushroom.





Oyster Mushroom
(Pleurotus ostreatus)

Common Substrates in Nature

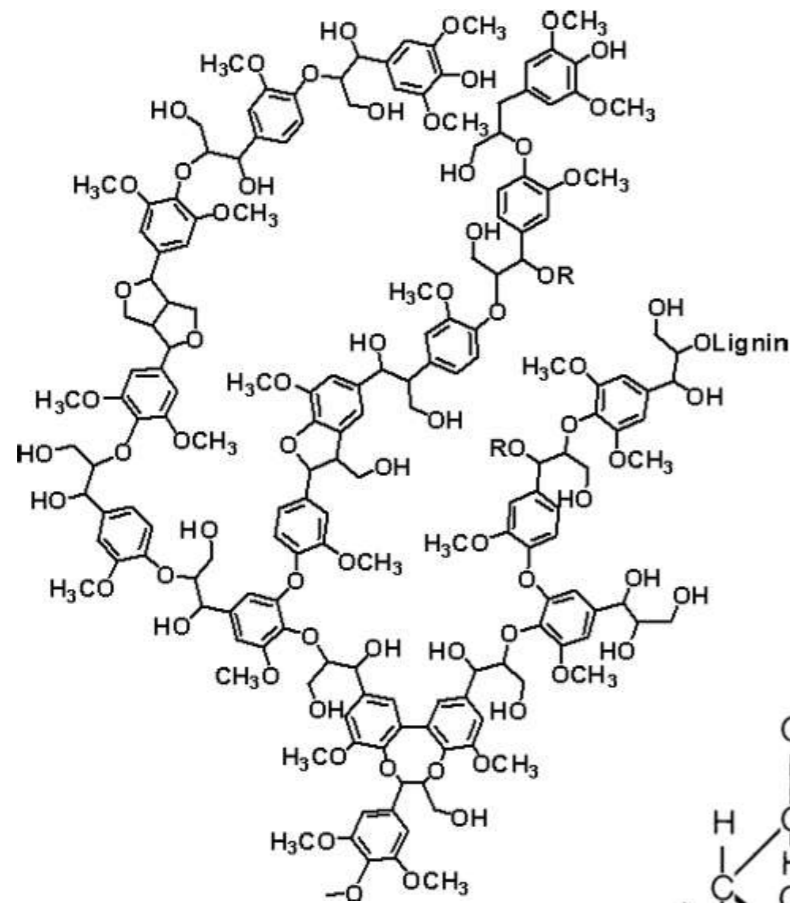
The Oyster Mushroom is a saprotroph.



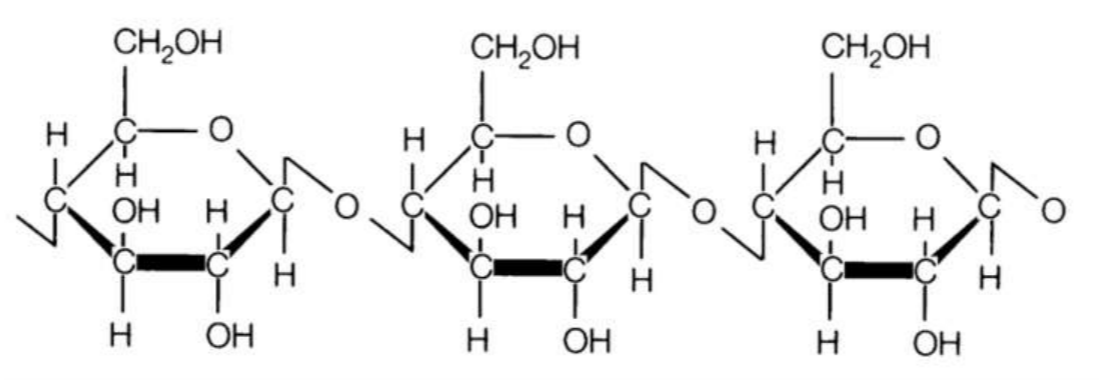
Even when growing on living trees, it is feeding upon the dead and dying wood inside the tree, decomposing the constituent elements and returning them to the forest in other forms.

Imagine the inside of a
decaying tree:

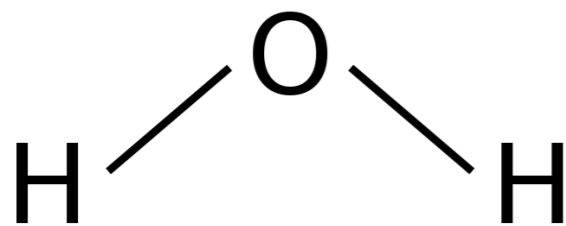
Lignin



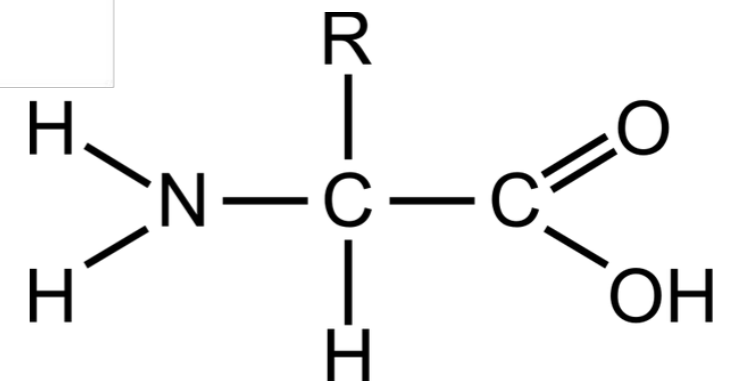
Cellulose



Water



Amino Acids

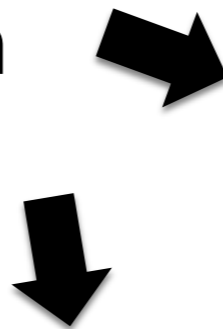


Brown Rot and White Rot

Certain fungal species break down specific parts of the molecular structure of wood.

White Rot

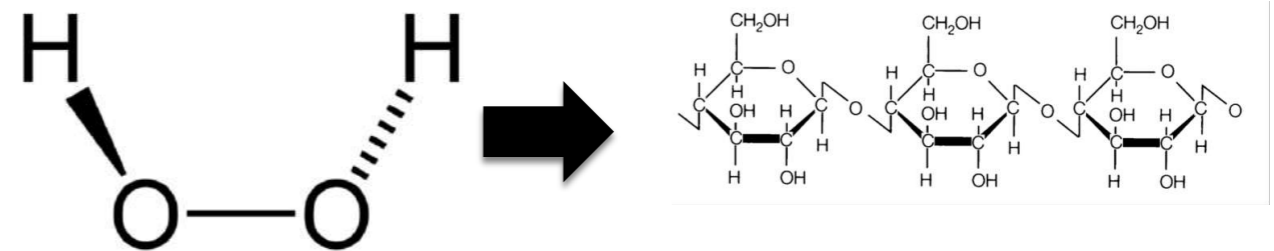
- Breaks down lignin and cellulose



Oyster
Mushroom

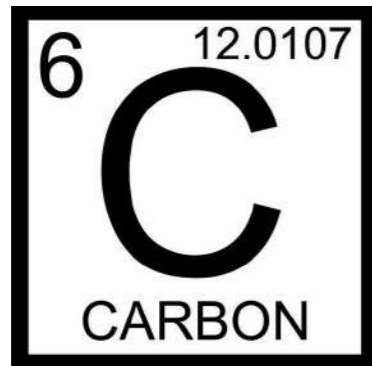
Brown Rot

- Breaks down cellulose



Honey Mushroom

A Balanced Fungal Diet



Necessary for cellular energy and construction of cellular structures.

Acquired by the fungus from sugars inherent in cellulose and lignin.



Important in the construction of enzymes that assist the fungi in metabolism and defense against other organisms.

Acquired from proteins and amino acids.



Button mushroom compost
13:1

Wood-loving mushroom substrate
40:1 - 60:1



← Fungi will grow on nearly anything!

- Bamboo
- Brewery Waste
- Cacao Shells
- Cacti
- Coconut and Coir
- Coffee Beans, Grounds and Debris
- Straws (wheat, rye, etc.)
- Sugarcane
- Tea Waste, Leaves and Trimmings
- Textiles
- Tobacco and Tobacco Stalks
- Trees, Shrubs, Brush, and Wooden Construction Waste
- Water Hyacinth

- Corn, Corncobs, Cornstalks
- Cotton and Cotton Waste
- Fabrics
- Garden and Yard Waste
- Hair
- Hemp
- Leaves
- Manure
- Nut casing and Seed Hulls
- Oils
- Paper Products
- Soybean Roughage



Cited in Mycelium Running, Stamets



The question, then, is how do we best replicate the circumstances that allow for successful mycelial growth and high bioefficiency?

Mycelial Concerns:

- Structure
- Nutrient Density
- Water Content

Human Concerns:

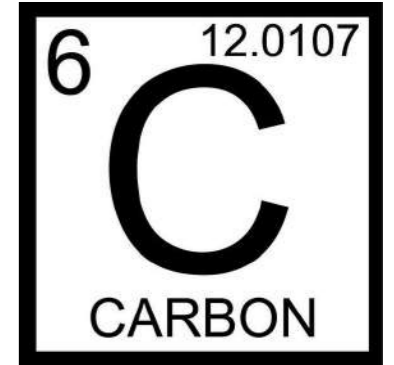
- Availability
- Affordability
- Sustainability

Carbon Sources: Wood or Straw?



Mushrooms can be grown on logs using plug spawn.

- Oak
- Elm
- Maple
- Ironwood
- Alder



The mycelium takes a long period of time to penetrate the hardwood.

6 mo. – 2 yrs.

Straw packed into grow bags provides the carbon that the mycelium needs in order to grow and artificially replicates the conditions of a decaying log.



Log Inoculation



Done in moist, temperate climates where the logs can be kept outdoors.

Availability of hardwood resources is also a concern when fruiting with this method.

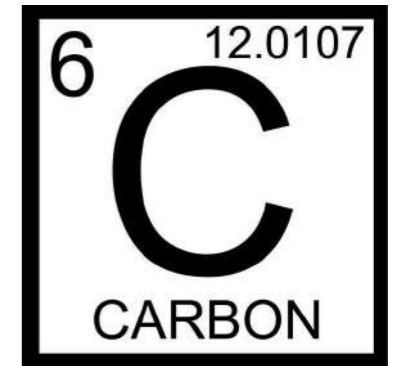


Plug spawn is hammered into holes drilled into logs.



Alternative Carbon Sources

Other materials can be used instead of wood or straw to satisfy the carbon content requirements of mycelium.



Corn Cobs



Sorghum Stalks



Wood Chips



Corn Stalks



Bufflegrass



Cardboard





Nitrogen Sources

Comprises less of the total substrate weight than carbon.

Seeds and Legumes

Mesquite Pods



Soy Beans



Alfalfa



Cotton Seed



Coffee Grounds



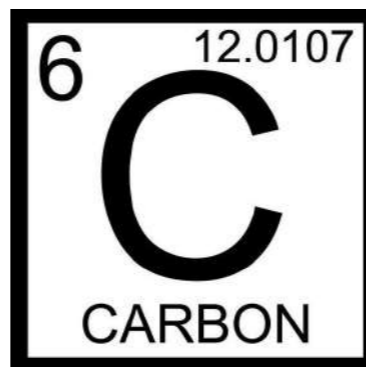
Lima Beans



Grain Bran



Substrate Ratios



One large burlap
seed bag (2700g
total dry weight)

Preparation of Substrates - Shredding

Woody, carbon rich substrate materials are shredded to increase surface area.



This can be done using a chipper-shredder or a weed-trimmer.

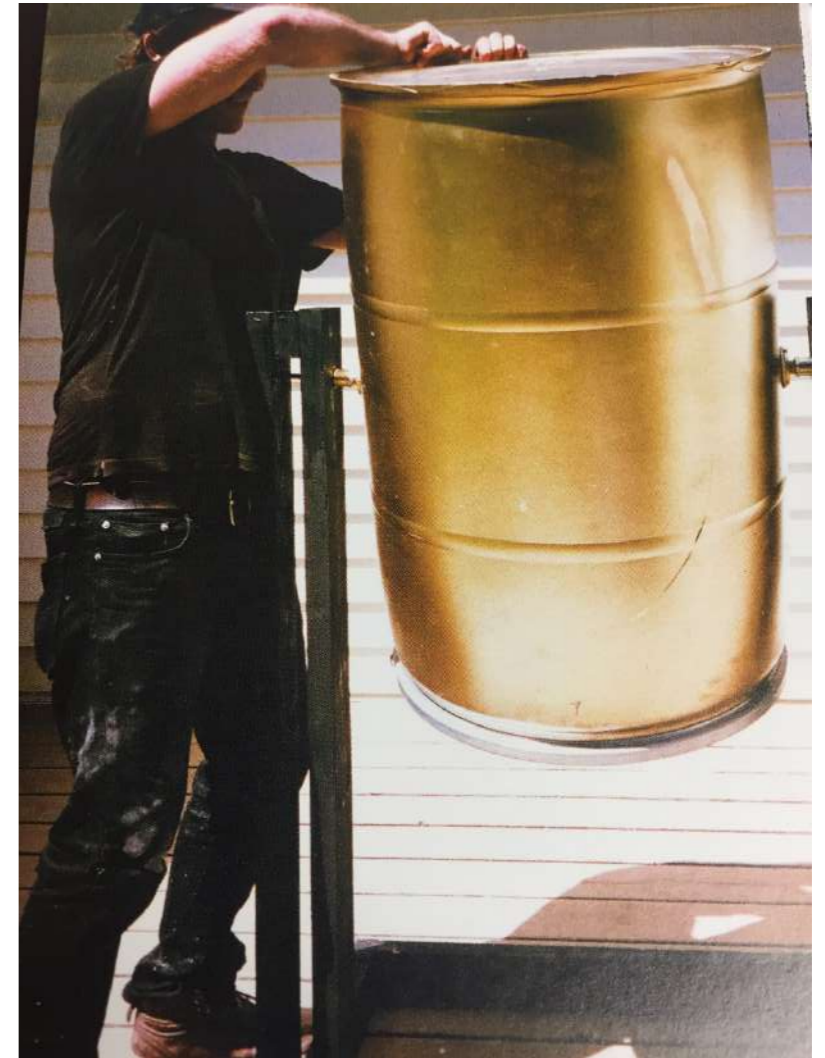


Preparation of Substrates - Mixing



Low
Tech

Medium
Tech



High Tech

Preparation of Substrates - Hydration



Depending upon the method of pasteurization used, pre-hydration may not be necessary.



To determine moisture content:

Dry Weight: 2700g

divide by Wet Weight: 8500g

$2700/8500 = 0.31$

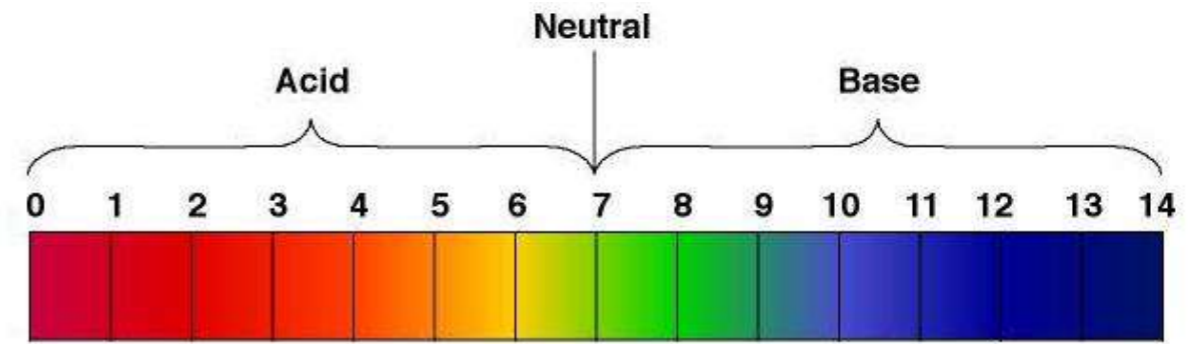
$\times 100 = 31.7\%$ dry

$100\% - 31.7\% = 68.3\%$ H₂O

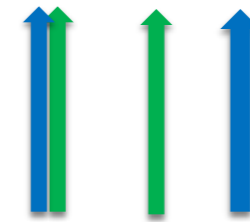
Fully-packed, dry substrate bags are soaked in water overnight to establish a moisture content of about **70%**.

pH and Mycelial Growth

pH can affect the fungus's ability to initiate the chemical reactions required to digest substrate.



The pH Scale



Optimal: 5 – 6.5

Possible: 5 – 7.5

pH can be tested with an inexpensive meter.



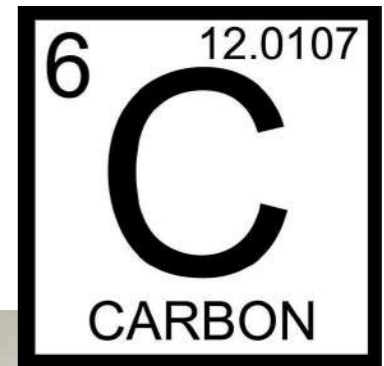
If necessary, pH can be adjusted using various additives.

Buffer pH - **Gypsum**

3 – 5%
of
substrate
weight.

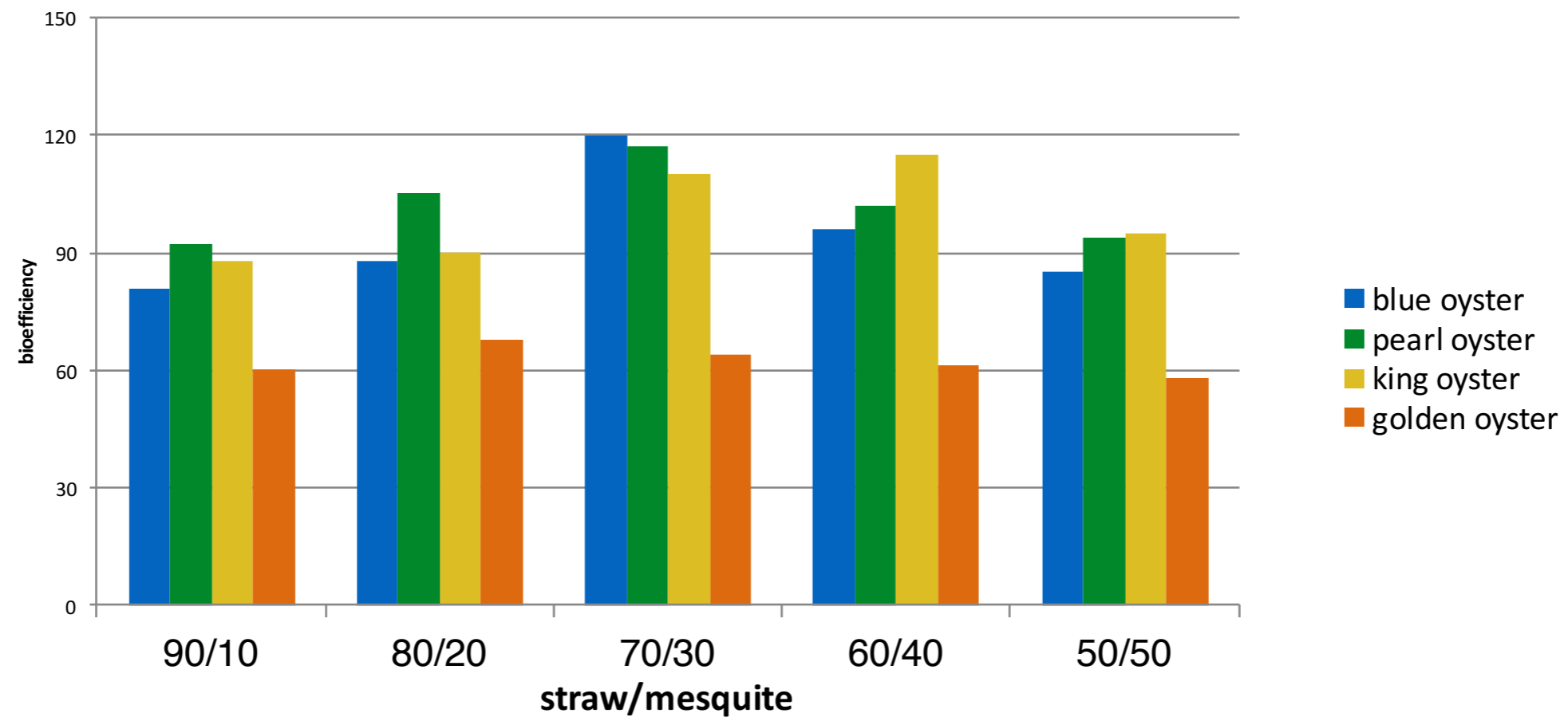
The substrate tends to acidify as mycelial growth/fruiting progresses.

Substrate Recipes – What We've Found



Dialing in the right substrate ratios

Effect of substrate ratios on bioefficiency



P. ostreatus



P. columbinus

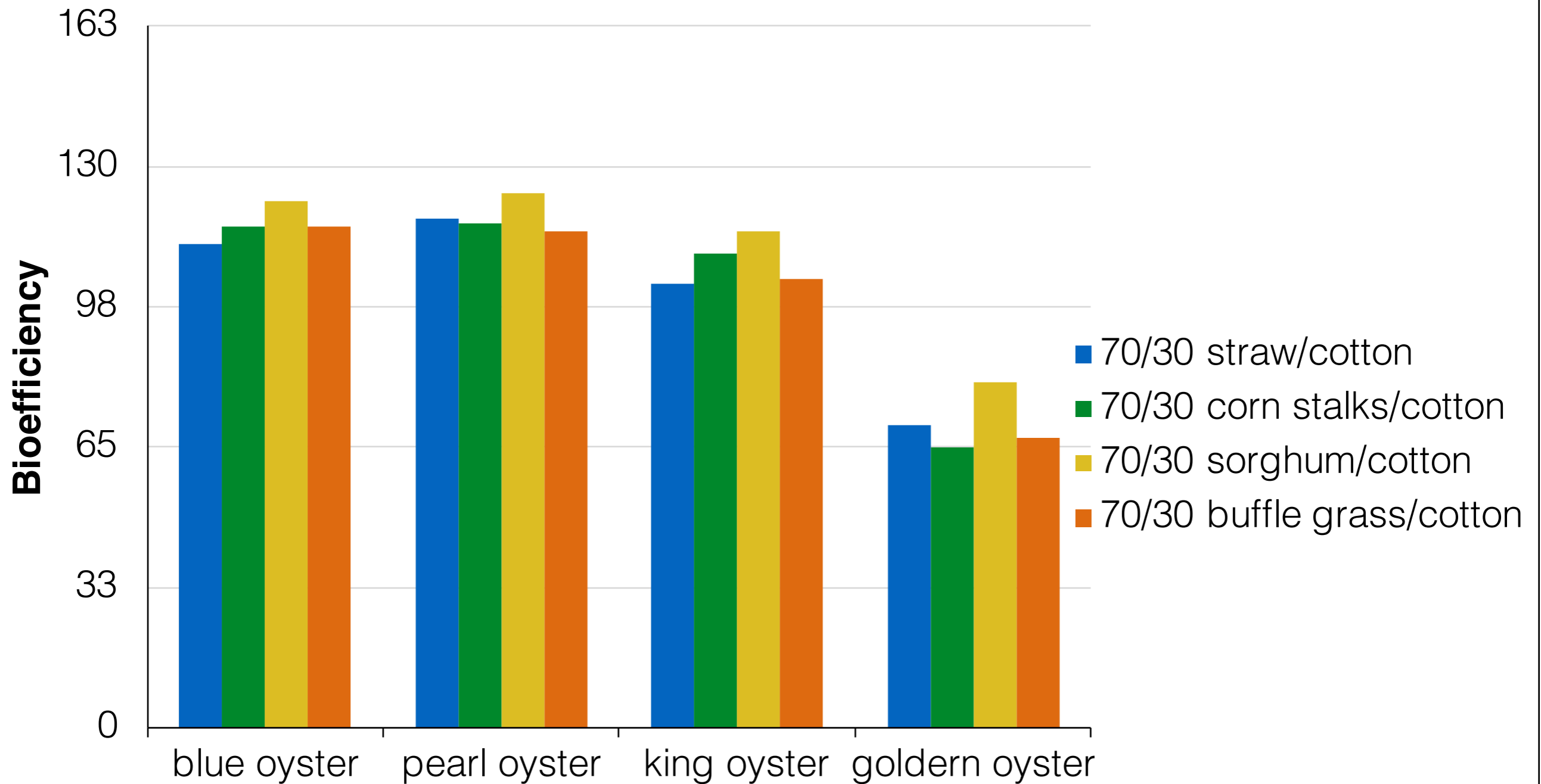


P. eryngii

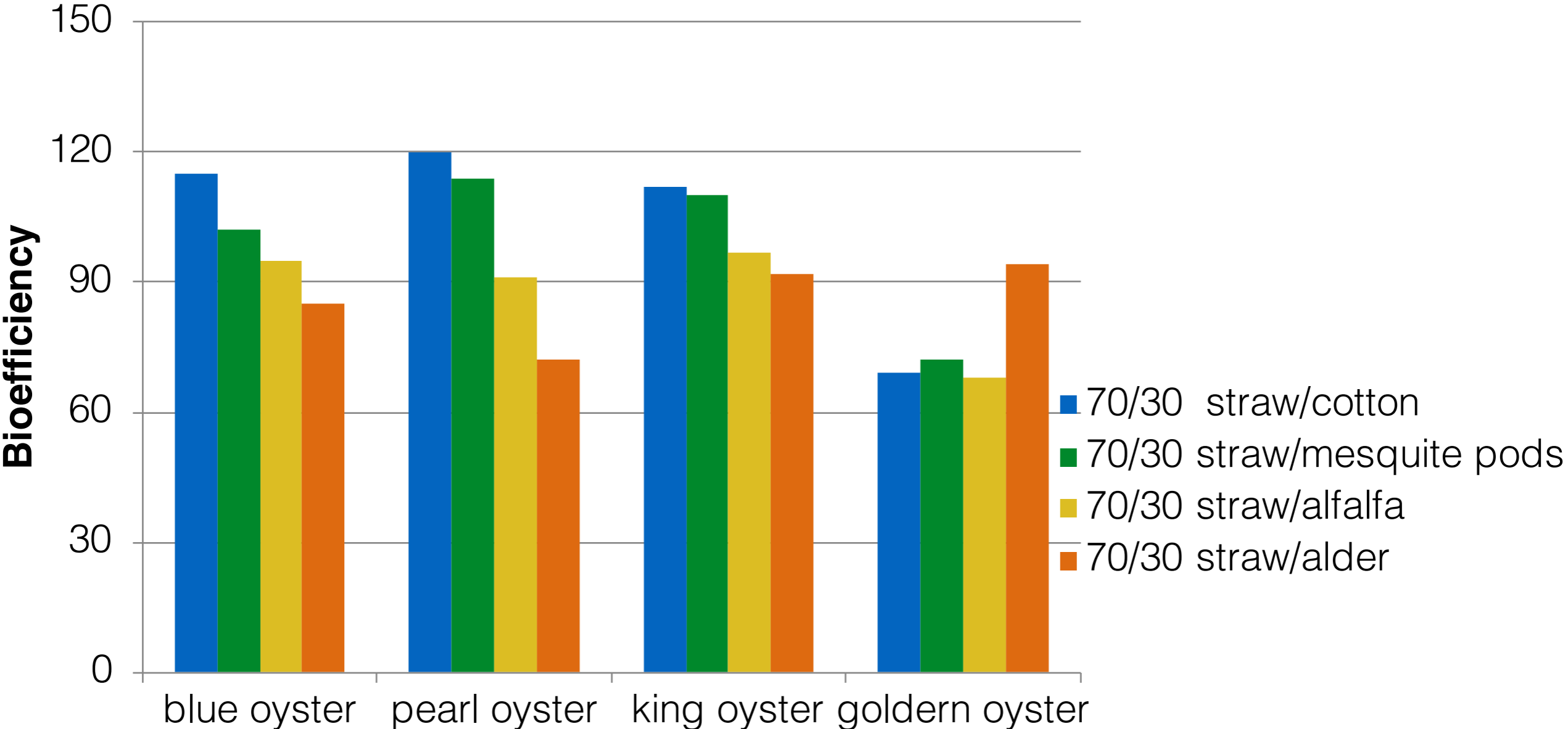


P. citrinopileatus

Effect of substrate carbon on bioefficiency



Effect of substrate nitrogen or additives on bioefficiency



Other Substrate Amendments

Alkalinizing Agents

- Wood Ash
- Hydrated Lime
- Chalk
- Oyster Shell
- Limestone
- Ground Limestone
- Limestone Grit



Other Amendments (N and Texture)

- Gypsum
- Worm Castings (10% - 15%)
- Spent Malt
- Vermiculite
- Coconut Coir

In Summary...



- Mushrooms will grow on nearly anything!
- Not all substrates will produce a high bioefficiency.
 - Straw and cotton produce most efficiently.
- There are many novel substrates that can be worked with.
 - Amendments can be incorporated into substrates if necessary.