Food Science Experiment

Department of Chemistry

Carleton University

Experimental Context

- Food systems are not currently sustainable
- Globally, up to 14% of food produced is lost between harvest and retail; another 17% is wasted at home, in retail, and foodservice
- When this food is lost or wasted, so are all the resources needed to produce the food
- Synthetic fungicides and food preservatives do help reduce food loss and waste but not without consequences on climate change
- **Natural preservatives derived from plants are therefore an attractive alternative to improve the sustainability of our food systems**

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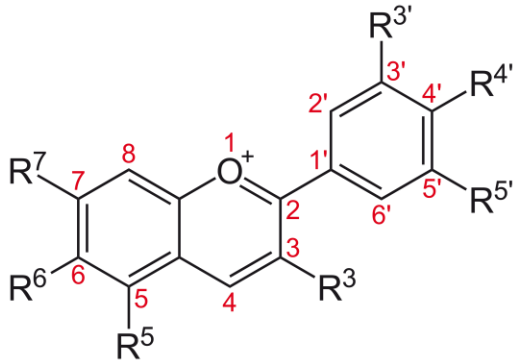
Experimental Context

- Plants like fruits, vegetables, and spices produce diverse chemical compounds throughout their life cycle
- These plant compounds may be responsible for several plant characteristics (colour, flavour) and functions (a plant's ability to make its own food)
- Some compounds produced by plants are a result of evolution and enable plants to survive tough conditions like disease, drought, extreme temperatures, cell damage, and other organisms
- Some properties of plant compounds are just like those of synthetic fungicides or food preservatives; resistance to stress and to spoilage microorganisms extends the shelf-life of foods

- **The plants that produce these fascinating compounds are foods we eat every day! Let's investigate their properties to determine whether they are good candidates as natural food preservatives**



Anthocyanin –
blueberry colour and flavour molecule with high antioxidant capabilities

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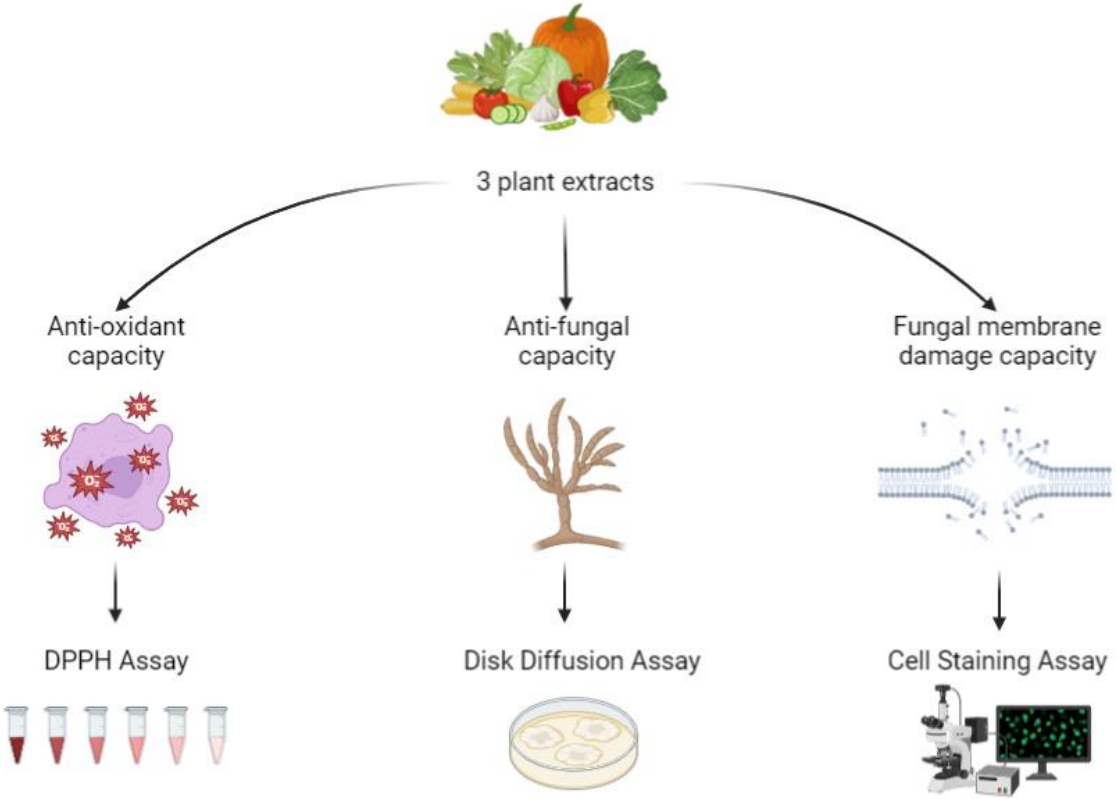
Experimental Overview



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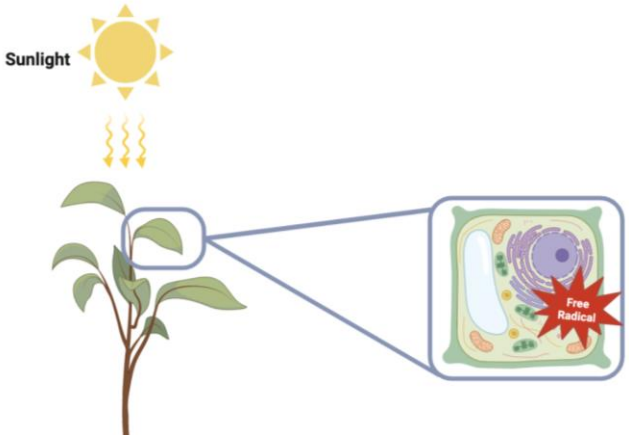
Anti-Oxidant Capacity



- Sunlight and other stressors can cause free radicals to form within a cell
- Free radicals are unstable atoms with an unpaired electron; they are highly reactive

- Free radicals can cause damage to cell organelles, DNA, and other important molecules like enzymes to impair functionality of plant cells
- In plants and food, free radicals can also attack structural lipids and proteins, resulting in rancidity, loss of texture, and food degradation
- **Anti-oxidants are capable of stabilizing free radicals and preventing plant and food damage**

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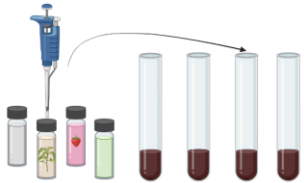
Anti-Oxidant Capacity

- The DPPH Assay can measure the anti-oxidant capacity of plant extracts
- DPPH is a free radical with a purple colour; in the presence of anti-oxidants, the DPPH free radical is reduced to a stable compound that is colourless or light yellow

1

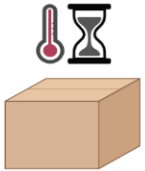
Add purple DPPH reagent to test tubes

2



Add controls or plant extracts to specific test tubes

3



Incubate in the dark for 30 min

4

Observe and note colour changes

- **The degree of the DPPH solution colour change after incubation with plant extracts indicate the anti-oxidant capacity of the plant extracts**

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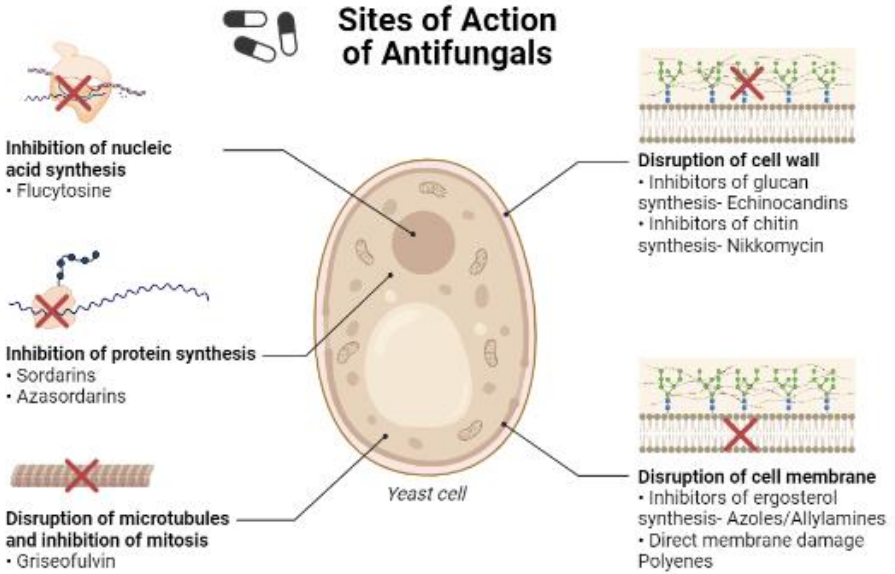
Anti-Fungal Capacity

- Plants are exposed to microorganisms, including fungi, that are present in the environment
- Fungi threaten plants by causing disease, eating the plant, or eating the plants' food
- As a result, some plants have evolved to produce anti-fungal compounds
- **Plant anti-fungal compounds attack many fungi sites necessary for fungi growth; if fungi can't grow, they can't spoil plants and food!**



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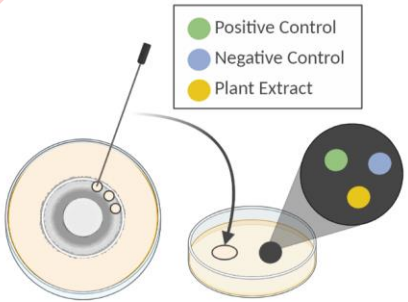
Anti-Fungal Capacity

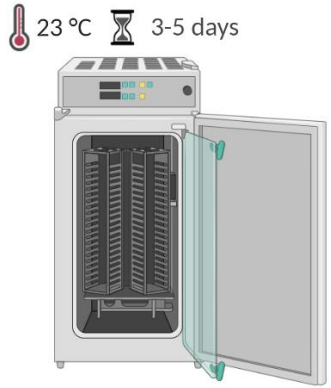
- The Disk Diffusion Assay assesses the anti-fungal capacity of plant extracts by measuring how much/little fungi grow with the nearby presence of plant anti-fungal compounds

1



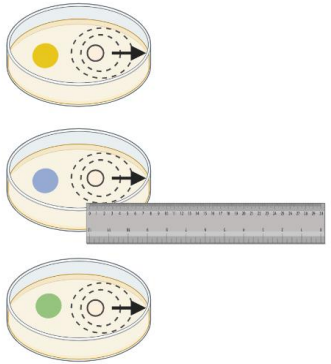
Transfer fungi plug to a plate in the presence of plant extract or control

2



Incubate plates to promote fungal growth

3



Measure diameter of inhibition zone around fungi caused by anti-fungals

Done prior to your visit

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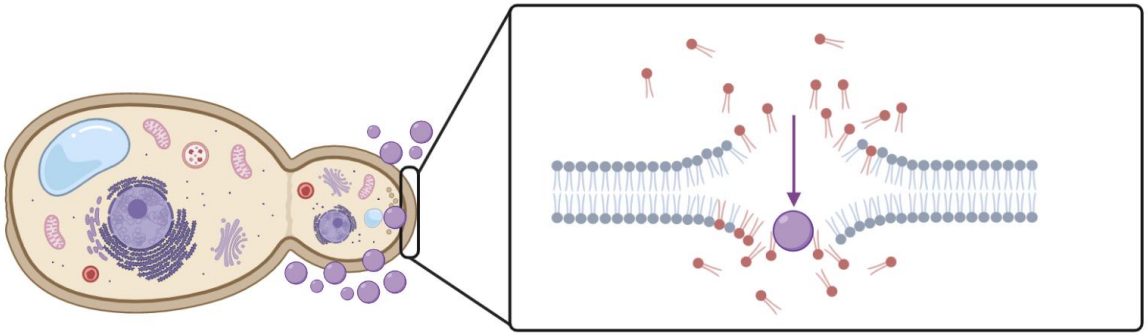
Fungal Membrane Damage Capacity

- A common mechanism of action of plant anti-fungal compounds is to puncture the fungal cell membrane through physicochemical interactions
- Fungi are unable to repair these punctures, causing their cell content to leak out and die
- Since dead fungi are unable to replicate, the fungi infection is eliminated



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Fungal Membrane Damage Capacity

- The Cell Staining Assay can show whether anti-fungal compounds in plants have punctured fungal membranes using fluorescent dyes; if dyes can be seen inside the fungal cells, we know the fungal membrane was damaged

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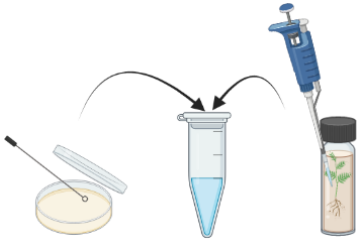
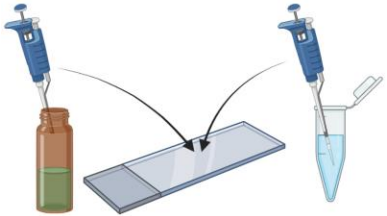


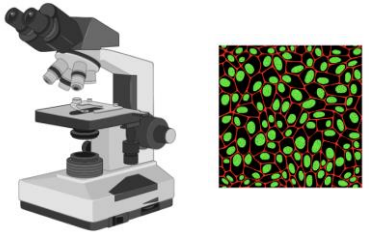
Fungal spores, plant extracts, and water incubate for 1 hour

2



Suspension and flurescent dye are mixed on microscope slide; incubate for 10 min

3



View slide with microscope and record observations

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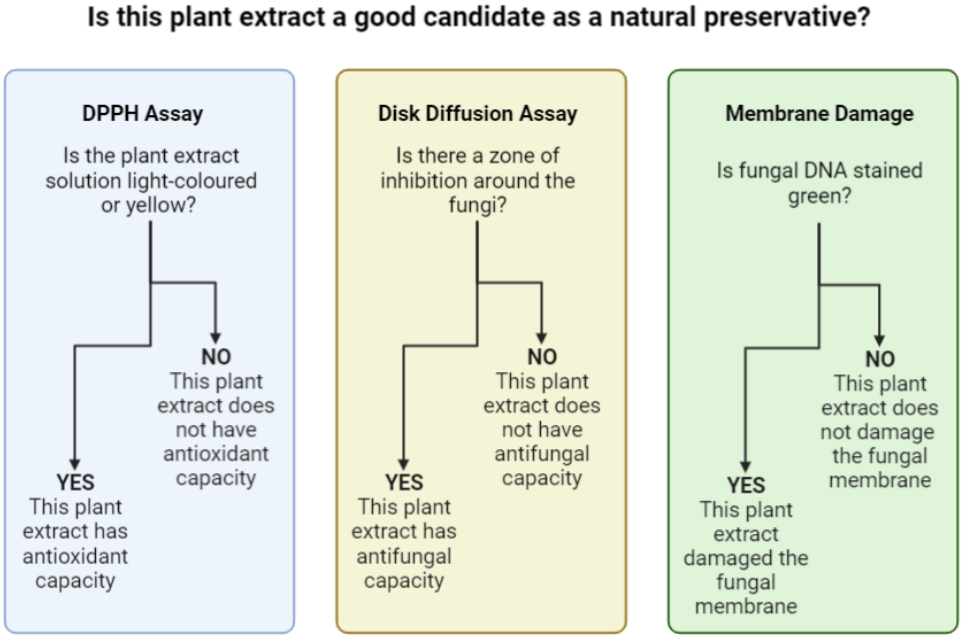
Decision Tree

- As you work through the assays, use this decision tree to identify which plant extracts could be an effective natural preservative
- **A good preservative should prevent damage from free radicals and stop growth of fungi; evidence of membrane damage is a bonus!**
- A document will be created to track and compile our results



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