Plant Synthesis: Cabbage

Used to synthesize silver nanoparticles ranging from 15-30nm.

Protocol:

Cabbage aqueous plant extraction

1. Cut cabbage into small fine, thin strips and weigh out 25 g on a scale.
   - Do not mince the cabbage, as this could cause loss of the juices of the vegetable which contains the active ingredients for later nanoparticle synthesis.
   - Cutting the cabbage smaller without squeezing the vegetable too much allows for increased surface area of the vegetable to be exposed for extraction of the vegetable's juices - this is optimal for production of cabbage extract
2. Wash the cut cabbage thoroughly with dH2O.
3. Dry the washed cabbage with paper towels.

Perform all of the following steps in a FUME HOOD:

4. Using a 200 mL graduated cylinder, measure out 150 mL of ddH2O.
5. Pour the 150 mL of water into a clean 250 mL beaker and place the beaker on a hot plate. Allow the water to reach a boil on the hot plate.
   - To quicken the boiling of the water, a watch glass can be placed atop the opening of the beaker.
6. Place the pieces of washed and cut cabbage into the boiled water in the beaker.
7. Boil the cabbage and water mixture for 5-10 mins.
8. While the cabbage is boiling, take a new clean 250 mL Duran bottle and cover its surface in aluminum foil so its contents can be protected from light exposure.
9. Place a funnel with a Whatman paper 1 filter coating its opening, at the mouth of the aluminum foil-covered Duran bottle.
10. While wearing the proper oven mitts, pour the boiled cabbage solution into the Duran bottle through the filter-coated funnel to remove the chunks of remaining cabbage from the cabbage extract solution. Perform additional filtrations with 0.45 um and/or 0.22 um filters if desired. (additional filtrations have shown to narrow the range of potential sizes of silver nanoparticles to within 30-50 nm). Cap the bottle once the transfer is complete.
11. The cabbage extract can be stored at 4°C in the Duran bottle.
    - Do NOT place the cabbage extract solution in a freezer (at -20°C or -80°C) - freezing the solution will alter the active ingredient in the cabbage extract and decrease yield of nanoparticles during synthesis
    - Keep the cabbage extract solution **away from light** to prevent breakdown of reactive species in solution.

Silver (spherical) nanoparticle synthesis using cabbage aqueous plant extract

1. Gather the cabbage extract solution from storage in the 4°C fridge.
2. Prepare 90 mL of 1 mM silver nitrate (AgNO3) solution in a 150 mL beaker/Erlenmeyer flask.
   - On a scale, weigh out 0.01529 g (15.29 mg) of AgNO3 solid
   - Using a 100 mL graduated cylinder, measure out 90 mL of ddH2O
   - In the ***fume hood***, pour the water into a 150 mL Erlenmeyer flask coated in aluminum foil - wrapping the flask in foil will prevent the solution from being exposed to light as the silver nitrate is light sensitive
   - Add the measured quantity of AgNO3 solid to the flask with water in the fume hood
   - Seal the opening of the flask with Parafilm and mix the solution by inversion

3. Using the same graduated cylinder from Step 2, measure 10 mL of cabbage extract solution.
4. Pour the measured cabbage extract into the Erlenmeyer flask in the fume hood containing the 1 mM AgNO3 solution.
5. Cover the opening of the flask with Parafilm then invert the flask to mix the solution.
6. Let the solution in the flask sit at room temperature for 12 hrs to allow nanoparticle synthesis.
    - After 3 hours, the solution should undergo a color change to **dark brown** or **honey brown** indicating nanoparticle formation
    - To view the color of the solution, peel back some of the aluminum foil to view the contents of the flask - once done viewing, cover the flask properly to limit the solution's exposure to light
7. Following nanoparticle synthesis, the solution can be stored at room temperature.

Source: Tamileswari, R., Nisha, M. H., & Jesurani, S. S. (2015). Green Synthesis of Silver Nanoparticles using Brassica Oleracea (Cauliflower) and Brassica Oleracea Capitata (Cabbage) and the Analysis of Antimicrobial Activity, *4*(04), 1071-1074.