CHAPTER 22

Ethnobotany

LABORATORY ACTIVITIES

Activity 22.1: Plants That Provide Drugs
Activity 22.2: Plants That Supply Fibers
Activity 22.3: Spices and Flavors
Activity 22.4: Daily Log

GOALS

Following this exercise, students should be able to:

- Describe the uses of different plants that provide drugs.
- Describe the uses and processing methods of different plants that provide fibers.
- Describe the uses of different plants that provide spices.

INTRODUCTION

Ethnobotany is the scientific study of the relationships between plants and people. An ice age covered much of the northern hemisphere in permafrost and glaciers during the Pleistocene epoch while some areas of the southern hemisphere remained unfrozen. During this point in time humans subsisted nomadically by hunting animals and gathering berries, seeds, and firewood. People began to cultivate and domesticate crops as long as 11,000 years ago, after the ice age came to an end and the earth began to warm. Interestingly, agriculture seems to have been independently discovered in at least four different locations on different continents. Potatoes, cultivated by the Inca people of South America might have been the very first domesticated crop. Next, wheat and lentils appeared around 9,000 years ago in the Fertile Crescent, which stretches from southern Turkey to western Afghanistan. Around that same time, the people of Southeast Asia began to cultivate rice, and pearl millet was soon domesticated in Africa. With domestication of crops came the necessity to tend and defend the land which led to the formation of permanent settlements. Hence, the development of civilization followed soon after the appearance of agriculture. People rely on plants not only for food, but also for medicine, spices, fibers, ornamentation, and overall enrichment of life. As you complete this lab exercise, try to think of other examples of ways that plants are important in your everyday life.

ACTIVITIES

Name

Date Section

Activity 22.1: Plants That Provide Drugs

Materials:

- Assortment of tea bags including black, green, and herbal teas
- Boiling water
- Teacups or other vessels
- Assorted types of ground coffee beans of different varieties and roasts
- A coffee maker and filters or French press
- Accompaniments such as sugar and milk (if you have access to a cafeteria or other food-safe area where the beverages can be safely prepared and consumed)

Tea is an ancient beverage prepared by steeping the leaves of *Camelia sinensis* in hot water (Figure 22-1). First the young leaves are picked, quickly steamed, and then lightly bruised to disrupt the cells and allow oxidation to take place. This oxidation process is termed **fermentation** even though it is an aerobic process distinct from anerobic alcohol fermentation. Green tea is only very lightly fermented which produces a natural flavor and light-green color. Black tea is fermented for several hours longer, which produces a bolder flavor and darker color than green tea. **Caffeine** is a water soluble stimulant and diuretic that is present in the leaves of *Camelia* sinensis and some other plants. The plant produces caffeine as a **secondary metabolite**, a substance that is advantageous to the plant in some way but not directly involved in its growth and metabolism. Plants produce caffeine because it can be toxic to insects in high doses; we enjoy caffeine because it gives us an energy boost in the morning. However, heavy use of caffeine can cause anxiety and insomnia, and abrupt abstinence from caffeine can cause symptoms of mild withdrawal in habituated users. Herbal teas contain dried leaves, flowers, and fruits of other plants besides *Camelia sinensis*. Most herbal teas are caffeine-free, which might or might not be desirable to the consumer.

In this exercise, you will compare and contrast different varieties of tea and coffee. If you have access to a cafeteria or other food-safe area, you might be able to taste the different varieties of these beverages if you so desire. If no food-safe facilities are available, only observe the beverages and note their aromas. Your lab instructor will give you specific instructions.

1. Obtain tea bags, boiling water, and vessels from your instructor or bring your favorite type of tea from home.

FIGURE 22-1 All three teas here are leaves of *Camellia sinensis*. The one in the center is green tea, in which the leaves are allowed to ferment only briefly. For black tea (on the left), the leaves are fermented longer to alter the flavor and reduce the astringency. For oolong tea (on the right), the leaves are fermented an intermediate amount of time.

2. Prepare a cup of each variety of tea according to the package directions. In the space that follows, record your tea varieties. Does the package state from what countries your teas originated? What amount of time and temperature is recommended for steeping each type of tea?

3. As your teas steep, take another one of each type of tea bag and open it. Observe the appearance of the plant matter. Record your observations here.

4. After steeping, remove the tea bags (don't squeeze them!) and compare the color and aromas of the tea varieties. Record your observations here.

5. Which of your varieties are derived from the *Camelia sinensis* plant? How are they processed differently?

6. Which of your teas are not derived from the *Camelia sinensis* plant? From what plants is your herbal tea made? What specific parts of these plants are being used to make the tea?

7. If your tea is being prepared in a food-safe area, and if your lab instructor gives you permission, you can taste the different varieties of tea and record your observations in the space that follows. How do the different varieties compare to one another in taste? Which one do you prefer? Do you enjoy milk and sugar or other accompaniments with your tea? If tasting of your tea is not allowed, you can record observations from your previous experiences with teas.

Coffee is an infusion prepared from the roasted and ground seeds of two species of small trees; *Coffea arabica* and *C. canephora*. Coffee seeds are called "beans" but they are in the family Rubiaceae and not a member of the legume family (Fabaceae). The beans are harvested and separated from the pulp before being cleaned and dried. The dried green coffee beans are then shipped to their destinations all over the world where they are roasted to varying degrees and ground to different textures. Roasting the coffee beans caramelizes the sugars in the fruits and produces a darker-colored beverage (Figure 22-2). The roasting process also reduces the caffeine content of the beans. Darker roasted beans will have a more robust flavor and darker color with lower caffeine content than would be produced from a lighter roast.

1. Obtain samples of different varieties of coffee from your instructor or bring your favorite from home. Make sure to include different roasts and varieties.

2. The instructor or a responsible member of the class should use the coffee maker or French press to brew a pot of each variety of coffee and distribute it to the class members.
3. What varieties of coffee are available in class today? Does it say on the package from which species of coffee plant they originated? From what part of the world did these beans originate?

FIGURE 22-2 These coffee beans (*Coffea arabica*) have been roasted to alter their flavor, caramelize the sugars (this gives their dark color), and to bring oils to the surface. Before roasting, they were green, astringent, and had much more caffeine than now.
Courtesy of Tommy R. Navarre

4. Note the aroma and coloration of each cup of coffee as you receive it. How are they alike? How are they different? How did roasting of the beans affect the color of the prepared beverage?

5. Again, if your beverages are being prepared in a food-safe area and your lab instructor gives you permission, you can taste your cup(s) of coffee. How do the different roasts compare to one another in taste? Do you prefer accompaniments such as milk and sugar with your coffee? If tasting of the coffee is not allowed, you can record observations from your previous experiences with coffee.

COMPARE AND CONTRAST

1. What chemical is present both in coffee and tea that makes them so enjoyable in the morning?

2. Why might you feel the need to urinate more often after enjoying a cup of coffee or tea?

3. Why might you get a headache if you skip your normal cup of coffee in the morning?

4. What are the benefits to drinking coffee or tea in the morning? The drawbacks?

5. What other plants can you name that are sources of helpful or harmful drugs?

6. What other products can you name that contain plant-based drugs?

Activity 22.2: Plants That Supply Fibers

Materials:

- Assortment of textiles and clothing
- Assortment of papers (notebook paper, toilet paper, paper towel)
- Scissors
- Wet-mount supplies
- Compound microscope

Plants are excellent at producing fibers. Their long strands of vascular tissues in the stem are often protected by a tough, bundle cap of phloem fibers. We take advantage of these types of fibers to make goods such as textiles and paper. Hemp (*Cannabis sativa*) is an excellent source of versatile fibers that can be used for clothing or paper. Hemp is an excellent source of fibers for paper because the plant is fast growing and easily cultivated, as opposed to using fibers from trees that take decades to reach maturity. Also, the leaves of monocots such as agave, palms, and many grasses produce usable fibers. Cotton (Figure 22-3) is the most important commercial plant fiber. The trichome fibers on the seed coat are harvested and processed before weaving into the cotton cloth with which we are familiar.

FIGURE 22-3 Cotton fibers are trichomes on the seed coat of cotton. Here, the seeds have produced such copious amounts of fibers that the fruits have been forced open, as is typical of domesticated cotton. Formerly, the difficulty of separating the trichomes from the seeds was so time consuming and difficult that it limited the use of cotton. The invention of the cotton gin by Eli Whitney greatly lowered the price of cotton and allowed the cultivation of cotton—and slavery—to expand greatly.

1. Cut a small piece of fabric from the textiles on display in the lab and make a wet mount. Observe the fibers under a compound microscope. Sketch your observations in the following space.

2. Observe the variety of textiles on display in the lab and worn by your classmates. Ask your lab partner to read the tag in your shirt collar. Then, do the same for your partner. What type of fibers is your clothing composed of? Can you tell where these fibers originated? Record your findings here.

3. Share your data with other members of the class. How many different types of plant fibers can you identify being worn by members of your class? In the following space, create a list and tally.

4. How many people in your class are wearing cotton clothing? What percentage of the class is that?

Paper is another important use of plant fibers. We use paper for many different uses: writing, shipping, storage, and packaging among other uses. Plant fibers for paper are primarily sourced by processing wood from cut trees. Our ravenous desire for paper has been a large factor contributing to deforestation across the globe. Additionally, trees are slow growing and can take years to come to maturity before they can be used to make pulp for paper. These factors together suggest that alternative sources of fibers, such as hemp, would be better suited for some paper production. Paper can also be recycled to reduce reliance on trees for pulp.

1. Tear off a small piece of notebook paper or newsprint, wet-mount it, and examine it under a compound microscope.

2. Can you see the individual fibers? Draw your observations here.

3. Now do the same with a (clean) piece of toilet paper. In the following space, draw your observations.

4. What other types of paper can you identify in your classroom? At home? What are the different uses of these products?

COMPARE AND CONTRAST

1. Compare the textures of the different textiles you saw in class today. How are they similar? How are they different?

2. Were all the textiles you examined today derived from plant-based fibers? If not, what other sources of fibers did you encounter?

3. What do you know about the history of cotton production in the United States particularly? What were the benefits of cotton production? What were the drawbacks? Discuss this topic with your classmates and record your thoughts here.

Activity 22.3: Spices and Flavors

Materials:

- Assorted spices and herbs
- Assorted peppers in a range of hotness (bell pepper, jalapeño pepper, ghost pepper)
- Cutting blade
- Nitrile gloves (optional)

The most important use of plants by humans is as a food source. However we also desire flavor and sensory excitement with our sustenance. Indeed, the search for spices was the driving factor behind the rediscovery of the Americas, circumnavigation of the globe, and nearly all other early worldwide explorations. Plants produce **secondary metabolites** for a variety of different reasons advantageous to the plant. Hot peppers overwhelmingly belong to the genus *Capsicum*; they produce the secondary metabolite **capsaicin**. These types of plants depend on birds to disperse their seeds. The fruits produce capsaicin to deter mammals from eating the fruits. Birds cannot detect the hot taste of capsaicin, whereas mammals can. The same evolutionary strategy which was originally intended to deter mammals from consuming the fruits of the *Capsicum* peppers now has the converse result of appealing to many humans. Indeed we have enhanced the heat of peppers with selective breeding, and we now rate the level of capsaicin on the **Scoville scale** of hotness. The bell pepper produces no capsicum and so has a value of 0.0 on the Scoville scale. The bhut jalokia or "Carolina reaper" pepper is the hottest in the world with a Scoville reading of 1 million Scoville heat units **(SHU)**. This reading means that if you were to add 1 mL of Carolina reaper extract to 1 million mL of water, people would still be able to detect the heat. Capsaicin is soluble in alcohol and lipids, but not water.

1. Observe the assorted spices on display in your classroom. Note their appearances and distinctive aromas. Have you enjoyed these spices in any dishes before?

2. From what part of the plant is each of these spices derived? For example, a clove is actually an unopened flower bud of the Indonesian tree *Syzygium aromaticum*.

3. From what part of the world is each of these spices sourced? Does it say on the packaging?

4. Obtain a selection of hot peppers from your lab instructor. You might want to don protective nitrile gloves for this exercise. Record the names of your varieties in the following space and make note of their appearance.

5. Based on your knowledge of the peppers at your table, try to place them in order of increasing heat as they would be ranked on the Scoville scale. Ask your teacher to check your assessment.

6. Cut each pepper open lengthwise. Be careful not to inhale the aroma too deeply or allow any material to come in contact with your eyes. Record your observations here.

COMPARE AND CONTRAST

1. How are all the spices you examined the same? How are they different?

2. Hot peppers originated in North America. You can see their influence in the flavor profiles of Mexican and southwestern cuisines. What other regional cuisines include hot peppers? You might want to go to the library or access the Internet to research the spread of the chili pepper out of North America.

3. What flavor profile is commonly used in the cuisines of your area? Describe the common combinations of spices used in your favorite local regional dishes.

4. Have you ever moved or gone on vacation to somewhere far away? How did the cuisine differ from what you normally consumed? Did you enjoy it?

5. Do you have a favorite dish or recipe? Where did you first eat this food? From where in the world does your recipe originate? Share recipes with the class and record some of your classmates' recipes below, as well.

Activity 22.4: Daily Log

Ethnobotany is a relatively new science that investigates the relationship between plants and people. Keep logs for the next 24 hours listing all the ways plants are useful in your everyday life. Make sure to include all the different uses of plants as you can come up with; don't just list the fruits and vegetables you eat that day. For example, this textbook is printed on paper which is made from plant fibers. The sugar you may consume comes from sugar cane, beets, or corn syrup. The processed flour used to make bread comes from wheat. Your clothes might be woven from plant fibers and colored with vegetable-based dyes. For the next 24 hours, try to fine-tune your way of thinking to consider the source of the things you have and use.

CASE STUDY—THE ICE MAN'S LAST TRAVELS

In 1991, German hikers came across the frozen body of a man at the bottom of a gully high in the Eastern Alps of Europe. Examination of his clothing and belongings showed that the deceased was not an unlucky modern day hiker, but a doomed Neolithic traveler who met his demise around 5,200 years ago. He was named Ötzi after the region of the Alps where he was preserved and discovered. Ötzi was equipped for travel; among other artifacts, he carried a bow made of yew (*Taxus baccata*) and 14 arrows of wood from the wayfaring tree (*Viburnum lantana*). He carried charcoal pieces of various woods in two containers made of birch (*Betula*) bark. The majority of the wood species found on him originated from the low montane valleys of the area. His shoes and clothing were made of tanned animal hides stuffed with middle-elevation sub-alpine grasses for insulation. He carried a woven grass mat (*Brachypodium pinnatum*) that he might have used either as a cape or a hat.

His intestinal contents included cereals, other unidentified dicots, *Sphagnum* moss, and meats. The cereal he consumed was identified as finely ground einkorn wheat (*Triticum monococcum*) based on the particle sizes of bran fragments present in his colon. The pollen content of his last meals showed that he had travelled from the high alpine region of the mountain to a presumed settlement at a lower elevation before returning to high elevation where he died. In 2001, X-ray and CT scans revealed that Ötzi had an arrowhead embedded in his left shoulder and several other traumatic injuries when he died. He might have bandaged his wounded hands with absorbent *Sphagnum* moss. All of these fragments of information put together lead to the hypothesis that Ötzi embarked on a journey from high altitude pastures to a settlement in the valley below where he had a disagreement with his neighbors or kin. He could have sustained his injuries in this altercation and been forced to flee back to the high altitude pastures he was familiar with.

1. Why would the discovery of a well-preserved Neolithic traveler be important to the study of ethnobotany or paleoethnobotany?

2. What can we conclude about Neolithic life from the remains of Ötzi the ice man?

3. *Sphagnum* moss is not a food source, yet fragments of it were recovered from Ötzi's intestines. Why might this have been the case?

STUDY GUIDE

- Understand what the study of ethnobotany is.
- Be able to describe several human uses of plants be they for food, fibers, flavor, or drugs.
- Be able to give examples of several plants that provide drugs or medicines.
- Be able to give examples of common plant-derived textile fibers.
- Be able to give examples of several different spices and tell from what part of the plant they are derived.
- Understand the Scoville scale and what it measures.

Conclusions

1. What is the study of ethnobotany?

2. How did the development of agriculture contribute to the formation of civilization?

3. What is a secondary metabolite and why do plants produce them?

4. What type of plant tissue do we use to make paper?

5. How do we measure the heat of *Capsicum* peppers? What do the numbers mean?

6. How have humans affected our forests by harvesting trees for paper and lumber?