

# The Incredible Edible Desert

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Sonoran Desert Discovery

Fall 2010

## **The Incredible Edible Desert**

### Topic:

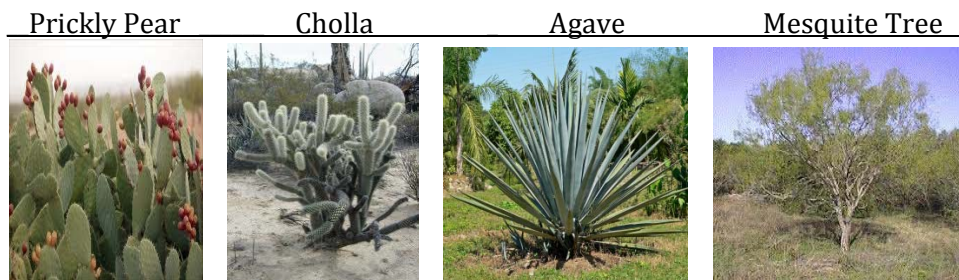
The goal of the workshop is to share information about the edible plant species of the desert. Along with this, we will discuss simple plant adaptations and survival tactics that allowed the plants to survive in such an extreme environment. Our guests will learn about desert natives and how they have used the plant species. The workshop will include useful information and fun facts about interesting uses of desert plants to treat ailments and the health benefits of the different species. Ultimately we would like to public to walk away with a greater understanding and appreciation of our incredible and edible Sonoran Desert.

### Introduction:

Imagine making a typical breakfast-bacon, eggs, and perhaps buttered toast with jam. If you are living in or around the Sonoran Desert, you might even be using prickly pear jam. Prickly pear jam comes from a native plant species in the Sonoran Desert. Before this plant was put into glass jars and sold as a breakfast condiment, it was enjoyed by animals of the desert. Prickly pear cacti, along with other native plant species, play a large ecological role in the Sonoran Desert community.

Before desert plants could be consumed and enjoyed by animals and humans, the plants had to overcome the hurdles of the extreme desert environment: lack of water, hot temperature, and little shade. Plants have evolved unique process and adaptations to efficiently use water and photosynthesize, as well as adaptations for defense against desert predators. Some of these plant adaptations, such as water storage in the pads of prickly pear cactus, happen to be beneficial to desert animals for nutrition and sources of water in extreme drought (if they can overcome the spiny plant defense!). Native Americans have also discovered ways of surviving in the desert and

have taken advantage of the assortment of nutrition the desert provides. Desert plants offer numerous health benefits in addition to being tasty,



### Plant Survival and Adaptations:

Prickly pear cacti represent about a dozen species of the *Opuntia* genus (Family Cactaceae) in the North American deserts. They are characterized by flat oval shaped fleshy pads. The pads are actually modified branches that are used for water storage, photosynthesis, and flower production (Comus 2000).

Chollas are also members of the *Opuntia* genus as well, but have cylindrical shaped stems rather than flat pads. Some species of cholla cactus have earned the name “jumping cactus” because they detach easily when brushed up against. Members of the *Opuntia* genus are unique because of their clusters of fine, tiny, barbed spines called glochids (Comus 2000).

Agave have a tall stalk ranging from 10 to 14 feet high and up to 4 inches in diameter. The stalk grows from a thick rosette of greyish green leaves. The leaves are 10 to 18 inches long and end with a sharp spine (Desert USA 1997). The tall stalk that shoots up through the center of the Agave makes it easily identifiable in the Sonoran Desert.

The mesquite tree is one of the most common shrubs in the Southwest desert (Herwig 2010). They range from only a few feet to around 10-15 meters tall (Sharp 2010). The trunk on the plant connects the roots to the leaves and provides overall nutrients. The mesquite often grows large

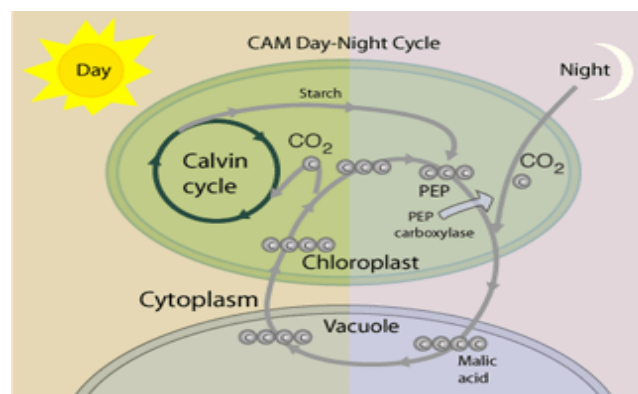
amounts of pods, which contain their seeds, and drop them frequently. Thus there isn't a rush to conquer the fierce spines of the mesquite for a quick treat, the pods are usually found lying around the tree.

### Plant Adaptations: Photosynthesis

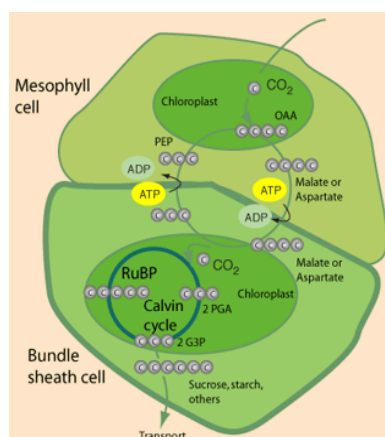
The Sonoran Desert environment is hot and dry. This is not ideal for water conservation. Plants are generally 60-80% water depending on the type (Biology Corner 2010). One adaptation that plants have developed to reduce their water loss in the desert is a modification to normal photosynthesis. Photosynthesis is the process by which plants use the energy from sunlight to produce sugar, which cellular respiration converts into ATP, the energy source for living things. The conversion of unusable sunlight energy into usable chemical energy is associated with the actions of the green pigment chlorophyll. Photosynthesis occurs in the stoma of a plant. The stomas are "pores" in leaves and stems through which CO<sub>2</sub> is taken in and O<sub>2</sub> is released. Plants control when stomata are open or closed. The sunlight enters through the stoma where bonding together of CO<sub>2</sub> with H<sub>2</sub>O to make sugar and oxygen occurs (Heller 2006). In addition, *Agave, Cholla, and Prickly Pear all have a waxy substance to reduce water evaporations and to act as a resistant layer.*

The three types of photosynthesis are C<sub>3</sub>, C<sub>4</sub>, and CAM. C<sub>3</sub> photosynthesis is the typical photosynthesis that most plants use and that everyone learns about in school. C<sub>4</sub> and CAM photosynthesis are both adaptations to hot and dry conditions because they use water more efficiently than C<sub>3</sub> photosynthesis. In addition, CAM plants can "idle," saving valuable water and energy during harsh times. C<sub>4</sub> plants can efficiently photosynthesize better under the desert's conditions of high heat and high light intensity. C<sub>4</sub> Plants work well under a high ratio of O<sub>2</sub>: CO<sub>2</sub> by using an extra biochemical pathway, reducing the amount of photorespiration. Under the same conditions, C<sub>3</sub> plants cannot survive as well (Heller 2006).

CAM plants close their stoma during the day, and open them at night when evaporation rates are much lower. The  $\text{CO}_2$  is converted to an acid and stored during the night. That stored acid is broken down during the day time, and the  $\text{CO}_2$  is released to the enzyme RUBISCO for photosynthesis. If conditions are extremely dry, CAM plants may leave their stoma closed night and day. The oxygen released from photosynthesis is used for respiration and  $\text{CO}_2$  given off in respiration is used for photosynthesis. The agave, prickly pear and cholla use the CAM cycle of photosynthesis (Heller 2006).



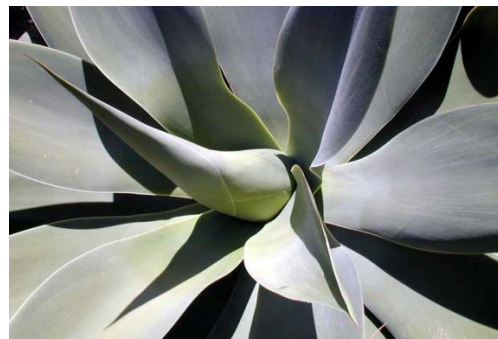
Unlike the CAM cycle of the cacti neighbors, the mesquite tree favors the  $\text{C}_4$  process of photosynthesis. The  $\text{C}_4$  process produces a four-carbon molecule called oxaloacetic acid. This acid is buried into the plant away from the air, and then split into compounds that produce glucose similar to the  $\text{C}_3$  method. This requires an extra step and more energy, however the trade off reduces photorespiration and does not require a lot of moisture to work (Heller 2006).



### Plant Defenses:

In the Sonoran Desert, water is hard to come by. In situations of draught, animals are thirsty and one way to obtain water is from the thick and juicy pads of cactus. Luckily the desert plants have evolved a way to detour the animals from eating the prickly pear flesh. The thorns and spines protruding from the cacti help protect from predators. These spines are not only a defense, but are leaves. Mauseth (2002) states, “Most cactus morphologists have concluded that cactus spines are either modified leaves or modified bud scales. The difference is inconsequential because bud scales themselves are modified leaves”.

The Agave has needle like points at the ends of their long leaves, acting as spines to keep the heart protected from outside predators (UBC 2002). The mesquite tree also has spines to warn away predators, although the thorns present on the tree are located on the actual trunk itself rather than leaves. The sharp, thick, needle like thorns are thickest near the base of the tree then gradually decrease as they ascend upwards. Mesquite trees use the spines to protect their trunk.



### Desert Plants as a Food and Shelter Source for Animals:

Animals have discovered numerous ways to overcome plant defenses and take advantage of the food and nutrition the desert plants provide. Plants such as the prickly pear, agave, mesquite and cholla all help in the survival of the desert animals. With the scorching hot temperatures of the desert, animals must remain cool. The best way to remain cool in the desert is to find shade. The mesquite tree offers shade and shelter for animals to keep cool since it has a wide area of branches

and leaves. Water is limited in the desert and a necessity of life. Some animals get all the moisture they need from the insects, plants and seeds they eat, and do not need to drink water. Most pass little moisture out of their bodies. They do not have sweat glands and pass only small amounts of concentrated urine (Sydenham 2002). In the spring time, the prickly pear produces the prickly pear fruit. This is a treat enjoyed by javelina along with desert tortoise. The flesh of the prickly pears and some chollas is eaten by jack rabbits, packrats and javelina, all of which can digest the high concentrations of oxalic acid that may be toxic to other animals (Comus 2000).



### Native Americans in the Sonoran Desert

Can you imagine trying to survive in the hot desert? Early Native Americans were able to find ways to successfully take advantage of the nutrition the desert provides and survive for thousands of years. Along with hunting, natives took advantage of the desert flora. The Hohokam were experienced farmers, and built complex systems for farming. In order to make this farming system successful, the Hohokam built the largest system of irrigation canals in pre-Columbian North America (Comus 2000). Agriculture really transformed the environments the natives lived in. Some common food items grown were maize, pinto and tepary beans, squash, and gourds, among many other plants.

Parts of the agave were eaten by natives. Archeologists found evidence of large roasting pits which contained charred pieces of agave (Comus 2000). O'odoham and other desert dwelling people ate

the flower buds of some species of cholla. The process to remove the spines and glochids is very laborious, and involves taking a stick and rolling the buds on the ground. Then, the buds are pit roasted and can be eaten immediately or saved for later consumption. O’odohom were wise to eat these in the before saguaro fruit ripening and just after the last year’s crops had been eaten (Comus 2000).

The prickly pear has been a food source for millions of people. Immature pads are generally eaten because they are more tender, and contain much less oxalic acid. Oxalic acid can be toxic in large amounts. Besides eating prickly pear, the juices from the pads has been used to strengthen adobe mortar (Comus 2000).

Mesquite trees are very common in the Sonoran Desert and have been used by Natives for thousands of years as a staple food. Tea, syrup, and ground up pods known as “pinole” can be made from the tree (Thorn 2000). The ground up pods can be used as a substitute for flour. This process as well is very laborious because the pods are thick and difficult to grind without the proper tools.

### Delicious and Nutritious

Prickly pear cactus, cholla cactus, agave, and mesquite trees have numerous health benefits in addition to being delicious. The edible pads are called “Nopales”, and are effective in controlling blood sugar levels that are associated with onset diabetes. There is evidence that the *nopales* help reduce blood cholesterol (Comus 2000). Agave nectar is used commercially as a natural sweetener and is typically added to teas or just used as a substitute to sugar. The great thing about agave sweetener is that it has a much lower glycemic index than sugar. Cholla cactus buds are very healthy and contain as much calcium and an eight ounce glass of milk. They are also very rich in fibers and help regulate blood sugars (Brody 2010). Ground up mesquite tree pods have a sweet taste to them, and can be used as a substitute for flour. Because the ground up flour is already



sweet, you can cut back on the amount of sugar used in a recipe. In addition, mesquite pods contain good sources of calcium, manganese, iron, and zinc (Brody 2010).

### Commercial Uses of Desert Plants

- Prickly Pear Jelly



-Prickly Pear Juice



-Prickly Pear Fruit Raw



Prickly pear cactus fruit can be made into a variety of jams and jellies commonly found in food stores. The cactus pads can be sold whole, or sliced into pieces and pickled for consumption.

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-Cholla Buds in Nature



-Cholla Buds Roasted



Cholla buds are often roasted after the spines are removed. This is a process often used by the O'odohom.

-Agave Tequila



-Agave Nectar



Several beverages are made from the sugar-rich juices of the mature agaves. The extracted juice is can be drank fresh as aquamiel (honey water) or fermented into pulque. The nectar that the agave produces has a similar taste to honey. Mature agaves provide food as well as beverage (Comus 2000).

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-Mesquite Pods



-Mesquite Flour



Mesquite beans are collected in the mid to late summer. The pods are collected when they are still hanging on the tree, then the pods are dried (Herwig 2010). They are generally yellowish brown at this stage. One way the pods are used is by grinding them into flour with a seed grinder/mill or something equivalent. The flour is sold at several stores and farmers markets.

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## Photos

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## **Workshop Details**

### Goal of workshop

The goal of the workshop is to share information about the edible plant species of the desert. Along with this, we will discuss simple plant adaptations and survival tactics that allowed the plants to survive in such an extreme environment. Our guests will learn about desert natives and how they have used the plant species. The workshop will include useful information and fun facts about interesting uses of desert plants to treat ailments and the health benefits of the different species. Ultimately we would like to public to walk away with a greater understanding and appreciation of our incredible and edible Sonoran Desert.

- Know the 4 plants
- What they can eat of each plant
- Simple plant survival mechanisms (CAM and C4 Photosynthesis, spike defense against predators)
- How natives took advantage of the desert plants.

### Activities

#### **-Hands on Activities**

##### **--- Prickly Pear**

- Pad (with out needles)
- Fruit (without needles)
- Fruit in bag, so the insides can be seen and 'felt'
- Peeling fruit

##### **--- Cholla**

- Raw buds (with out needles)
- Mesquite
  - Raw pods
  - Mesquite flour (Ideally have a mortal and pestle to grind the pods into flour)
- Agave
  - Leaf, with dull pointed end
- Edible Selections
  - Prickly pear
    - Pad that have been prepared
    - Raw fruit (if pealed)
    - Prickly pear jelly w/ crackers
  - Cholla
    - Roasted cholla buds
  - Mesquite
    - Raw pods
    - Mesquite flour
    - Mesquite bread
  - Agave
    - Nectar

Summary: The activities are all designed to be “hands on”. We want all of the visitors to get a unique experience with all of the four plant species on a touch, smell, and taste basis. We will have cactus pads-maybe cut one open-to show the water content of the pads. For a large class, we would show how much water is in the pads by crushing up the pads and using a strainer. Mesquite pods will be at the table along with something to grind up the pods (mortar and pestle). This would be a fun activity for children or adults to physically make the pods into flour, just as the natives have done. Another activity could be to show how the natives were able to remove the spines and glochids from chollas. Perhaps we could show the audience the cholla and ask how they might remove the spines. Then demonstrate or talk about how the O’odohoms accomplished this task.

### Materials

- |                               |                            |
|-------------------------------|----------------------------|
| - Table                       | - Prickly Pear (pads       |
| - Chairs                      | prepared, jelly, crackers) |
| - Poster                      | - Cholla (roasted buds)    |
| - Cups, plates/napkins to     | - Mesquite( flour, bread)  |
| hold food                     | - Agave (nectar)           |
| - Utensils (plastic)          |                            |
| - Prickly pear (raw pads, raw |                            |
| fruit, fruit in bag)          |                            |
| - Cholla (raw buds)           |                            |
| - Mesquite (raw pods,         |                            |
| mortal and pestle, bag of     |                            |
| flour)                        |                            |
| - Agave ( leaf)               |                            |

**Timing**

~30 Minutes (excluding tasting) --Classroom environment

Time (Minutes)	Topic
10	Species talk (unique characteristics, how to identify) <ul style="list-style-type: none"> <li>- Prickly Pear</li> <li>- Pads, fruit, 'insides'</li> <li>- Cholla</li> <li>- Raw buds</li> <li>- Mesquite</li> <li>- Pods, bag of flour</li> <li>- Agave</li> <li>- leaf, nectar</li> </ul>
5	Adaptation talk <ul style="list-style-type: none"> <li>- Spines</li> <li>- Photosynthesis</li> </ul>
10	Edible <ul style="list-style-type: none"> <li>- What parts are edible</li> <li>-How they are made edible</li> <li>- How natives used the plants</li> </ul>
5	Nutrition <ul style="list-style-type: none"> <li>- What nutritional benefits</li> <li>- Ailments etc.</li> </ul>
	Tasting

**Engagement**

For booth set up and presentation

Age	Main Points	Focal Points
Kids	Food Adaptations	Allow them to eat the different foods and see the plants that they come from. Show that cactus and other plants have sharp needles that can hurt
Teens	Food Adaptations	Allow them to eat the different foods and see the plants that they come from. Explaining how plants defend themselves <ul style="list-style-type: none"> <li>-Needles</li> <li>-Secretion of toxins</li> </ul>
Adults	Food Preparation Nutrition	Allow them to eat different foods and see the plants that they come from Explain how theses foods can be incorporated into everyday life. The nutritional benefits the plants posses

The format will be to educate on these main points to the age group determined. If concepts are understood at a basic level then divulge deeper. The hope is to encourage questions and inquires leading to other materials or topics presented on the table or poster.

## -Lesson Plan

### Preparation:

- Prepare all food ahead of time
  - o Bake/Buy mesquite bread
  - o Place jelly on crackers
  - o Prepared pads in cups
  - o Place pods and buds in individual containers
  - o Agave nectar on spoons
- Prepare teaching setting.
  - o Group together each species and its pertaining elements
  - o Ensure that both raw and prepared(manufacture) food are available

All food materials can be placed on a plate for each individual or each tasting item can be distributed separated

### Species

- Select an order for presenting the species in. Talk about each species:
  - o Identifying Characteristics
    - Color
    - Height/Size
    - Dominate feature
      - Prickly pear – Red Fruit, Large pads, prickly leaves
      - Cholla – Covered in spines, buds
      - Mesquite –Thorny trunk, seed pods, smell
      - Agave – tall stalk, sharp pointed ends
  - o Adaptations

How the plant is able to survive in the Sonoran Desert

Incorporate the raw species (Pads, pods, buds, leaf)

    - Spines
    - Photosynthesis
    - Toxin Secretion
  - o Edible Parts/Tasting

What parts of the plant are edible and how they are prepared

Would be good to talk about each plant then taste right after

    - Prickly pear
      - Prepared pads
      - Jelly on crackers
    - Mesquite
      - Bread
    - Cholla

- Roasted buds
- Agave
  - Nectar on spoons

#### Finishing Up

Ask questions to ensure understanding of material presented

Examples:

- What does each species look like?
- What parts can you eat?
- How does it survive in the desert?

#### Resources

- Recipe book of desert plant recipes
- Handout of a simple desert recipe-mesquite bread or cactus jelly.
- Plant props-physical example of each specie

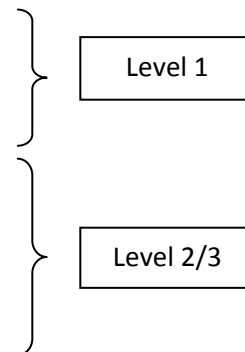
#### Discussion/Comprehension

Initial:

- Can you eat anything in your backyard?
- What desert plants are edible?
- Do you think cacti are tasty?
- What do you know about Prickly Pear? Cholla? Mesquite Tree? Agave?
- How do you think plants survive in the desert?

Comprehension:

- What does it look like?
- What on it can hurt you? Point to them?
- Which parts are edible?
- What distinct features?
- What adaptations? What photosynthesis process?
- What type of toxin is produced?
- How do you peel the fruit?
- What can be made from the plant?





## **Beyond the Activity**

The goal of the workshop is to share information about the edible plant species of the desert. Along with this, we will discuss simple plant adaptations and survival tactics that allowed the plants to survive in such an extreme environment. Our guests will learn about desert natives and how they have used the plant species. The workshop will include useful information and fun facts about interesting uses of desert plants to treat ailments and the health benefits of the different species. Ultimately we would like to public to walk away with a greater understanding and appreciation of our incredible and edible Sonoran Desert .We would like participants to leave the workshop and know the how to identify the plants we talked about, what parts are edible of each plant and how those plants survive in the desert. A greater knowledge would include an understanding of the natives took advantage of the desert plants.

### Uses and Ideas

This workshop could be used as a physical representation of plant adaptations and how desert natives lived off the desert. Following this workshop, photosynthesis could be explained in more detail; more information provided on general plant survival and adaptations.

-Describe photosynthesis (C3, C4 and CAM cycle)

-Survival both animal and plants of the desert

- Spines

-Venom

-Southwest Natives

- Coloring

- Poison

- Southwest culture/history

- Medicinal and health uses of plants

This workshop is a great tool to interest children of all ages in the Sonoran Desert. There are tons of hands on activities which allows for kinesthetic learning. The incredible edible desert opens the door to the bountiful world of the Sonoran Desert.

### Additional resources:

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## Glossary:

- Apical - top
- Basal – bottom
- C3 Photosynthesis - converts carbon dioxide into a 3 carbon molecule
- C4 Photosynthesis – converts carbon dioxide into a 4 carbon molecule
- CAM Photosynthesis – C4 photosynthesis but stoma open during the night
- Glycemic index- describes this difference by ranking carbohydrates according to their effect on blood glucose levels.
- Glucose ( $C_6H_{12}O_6$ ), a simple sugar a monosaccharide . Glucose is one of the main products of photosynthesis and starts cellular respiration.
- Glochids- clusters of fine, tiny, barbed spines.
- *Napolitos*-the young and prepared pads of prickly pear cactus.
- O’odham- a group of Native Americans who reside primarily in the Sonoran Desert of the southeastern Arizona and northwest Mexico.
- Photosynthesis- A process which converts CO<sub>2</sub> (Carbon dioxide) into oxygen and glucose.
- Stoma- a pore or hole found in the leaf and stem skin that is used for gas exchange.

**Assessment:**

We will know if our workshop is effective if we generate a lot of interest and get positive feedback from the guests. Our goals are to introduce our guests to the incredible Sonoran Desert and give them a hands on experience about some of the edible parts. In addition, we would like our guests to gain an appreciation of how these plants were able to survive before we could eat them. Plants have such unique adaptations to survive in the desert, and it would be great for people to gain an understanding of some of the processes. We have interesting information about the Native Americans and some of their early uses of the plants as well. Ultimately, we would like our guests to see that living in the desert as a plant, animal, or even human is not easy! Overtime though, this has become possible from adaptations from the plants and different survival skills from humans. Our guests will get to try numerous desert plants and commercial products from the plants-such as prickly pear tuna and agave nectar. To test if our guests have learned, we will have a picture matching section. This would be great for kids to see if they remember where some of the products come from. For older children and adults, we will ask questions to see what they remember. This will also help for future presentations to see what information is grasped. Another good indication will be to see if the guests ask questions, this way we know what parts of the presentation are interesting.

**Acknowledgments:**

We would like to thank Dr. Bonine for offering this course and an opportunity to expand our knowledge on the Sonoran Desert. We owe thanks to the three teaching assistants, Kelly, Tyler, and Josh for providing valuable feedback for different parts of the project. Many of our ideas came from the first trip to Mount Lemmon. On this trip we gained an appreciation for the desert and tried prickly pear cactus fruit and hackberries. We would like to thank Kimberly's Mom, Annette Engols, for providing cactus pads and fruit from Sierra Vista, along with desert recipe books. We would like to thank Season's mother, Marry Jean Eggleston, a teacher with a PhD in Psychology, for providing insight into different ways of teaching. Much of the information from our presentation came from "A Natural History of the Sonoran Desert". See reference page for a complete list of references.

**Online Print Advertising Paragraph:**

Come and explore the incredible edible desert! At this station you will learn about 4 plant species-the prickly pear cactus, cholla cactus, agave, and mesquite tree. Find out how desert natives have used these plants since thousands of years-both as food and as a way to cure common ailments. We will have tasty desert plants to sample. Not only are they delicious, but they are nutritious! Learn all about the health benefits the plants of the desert provide.

# The Incredible Edible Desert

Find out...

- What plants are edible in the desert?
- What are common food items made from desert plants?
- How have natives used the plants?
- Delicious and nutritious- find out about the nutritional benefits of desert plants.

**Best of all, come and sample some  
of the tasty desert treats!**

## **Self Evaluation and Recommendations**

First of all, we learned that having food available is the best way to attract people to the station! “Would you like to try cactus?”-this phrase worked 9 out of 10 times. Once we attracted people to our station, we gave them information about some of the edible plants in the Sonoran Desert. The majority of people that came by had never tried prickly pear cactus before, and were surprised at how tasty they are! Another great feature of our workshop was the matata mesquite pod grinding tool. People saw it and were curious what it is used for. This was a great transition to talk about how the Native Americans took advantage of the plants of the desert for resources. Most people had no idea mesquite pods can be used for flour. Some tried the flour from the ground up pods and were shocked by the sweetness. This tool was perfect for middle age children and gave them a little challenge to see if they could grind up the tough mesquite pods.

What really interested people was the actual food, the section about how Native Americans used the desert plants, and the nutritional and dietary benefits. The photosynthesis section didn’t spark much interest. This was expected since it is a booth and most people will only stop by for a few minutes. This piece of information is valuable nevertheless, and has a better place in a classroom presentation. So, for Saturday events or events where we only have guests for a few minutes, this part would be left out unless they specifically ask about it since it is on the poster. If we could change anything, we would try to get cholla cactus for eating. This was the only food source missing since we had trouble finding it. We would also want to include more information about the Native Americans since most people found it very interesting.

The next person using the workshop should first of all read and learn all about the four different species-prickly pear cactus, cholla cactus, agave, and mesquite tree. It is important to know the identifying characteristics, and how to distinguish between the species and other species that may look similar (for instance agave vs. aloe vera plant). The plant defenses and adaptations are important to learn about because this lets us know how the plants survive in the desert. Some of this, like water storage in plants, contributes to the nutritious advantages. A history of the Native Americans in the desert gives valuable information about how the desert natives were able to survive in the extreme environment. Many of these processes are still used today. Lastly, the presenter will need to understand some of the basic nutritional benefits of the plants. The presenter should try all the different plant species in case someone asks how to describe the taste of the plants.