Mesquite Flour

New Life for an Ancient Staple

Although mesquite is well known in the United States for the flavor its wood imparts to grilled steaks, fajitas, and seafood, very few people are aware that ground meal made from mesquite pods was of vital importance to prehistoric societies. Mesquite is the common North American name for woody desert plants of the genus *Prosopis*, which has about forty-five species native to North America, South America, Africa, and southern Asia. These species range from multistemmed, eight-foot-tall shrubs with trunks approximately two inches in diameter (found in the deserts of southern New Mexico) to sixty-foot-tall trees with six-foot-wide trunks that grow in the river bottoms of northwestern Argentina. As might be inferred from the presence of pods, mesquite is a legume that enriches the fertility of desert soils through nitrogen fixation.[1] As such, this tree is of great importance to many of the world's arid ecosystems.[2]

As a plant scientist involved in international development, I have a particular interest in mesquite pods and their potential for sustainable development. If economic markets can be developed from the sale of the pods, overharvesting of *Prosopis* for lumber, firewood, and charcoal in arid regions of Latin America, Africa, and India may be reduced. For example, in the province of Chaco, Argentina, more than one hundred thousand tons of *Prosopis* logs are processed annually for furniture manufacture, and with very few new forest plantings, this species continues to be overexploited. The economic future of this region may lie in the processing of mesquite flour, which has a long and storied history in the new world.

Mesquite flour was given in great quantities to the Spanish explorer Cabeza de Vaca, who made the first overland crossing of North America between 1528 and 1536; most likely it was processed from mesquite beans similar to those currently found on the Cahuilla Indian tribal lands near Palm Springs, California.[3] Pedro Castaneda chronicled the Coronado expedition of 1540–1542 in what is now northern Mexico and the southwestern United States, describing "bread of mesquite, which like cheese keeps for a year."[4] Hernando Ruiz de Alarcón, who traveled from Acapulco up the Colorado River in 1540, also described cakes of corn and mesquite.[5]

The full extent of the use of mesquite for human food in North America was not known until the late nineteenth and early twentieth centuries, when anthropologists conducted extensive interviews among the descendents of Indians who had used mesquite before being acculturated by the white man.[6] These anthropologists and ethnobotanists came to the same conclusion: although some Indian tribes, such as the Yuma and Cocopah, cultivated traditional foods in pre-Columbian times and wheat after the arrival of Europeans, mesquite beans were one of the major, if not the most important, food sources of the desert Apache, Pima, Cahuilla, Maricopa, Yuma, Yavapai, Mohave, Walapi, and Hopi tribes.[7] These beans, which typically contain about 30 percent sucrose, were quite sweet. However, the Indians distinguished trees that produced bitter pods from those that produced sweet, nonastringent pods, and in some tribes individual families maintained ownership of selected trees. A single grove can contain trees that vary greatly in bitterness. Clonal selections are made from the sweet trees for use in reforestation programs.[8]

During the harvest season in June or July, the women and children often remained in the groves until the pod harvest was complete, after which great quantities of mesquite products were stored to provide food year round. Many of the desert Cahuilla Indians of California stored the mesquite beans intact on the roofs of their dwellings in large elevated baskets woven of arrow weed or willow twigs and sealed with mud. The largest wicker baskets held ten to fifteen bushels each, a quantity sufficient to feed a family of six to ten people for a year.[9]

Some Maricopa Indians processed the pods prior to storage. Maricopa women pounded the pods into meal in a cottonwood or mesquite mortar, sifted the meal into fine and coarse grinds, and then poured the fine meal into an elliptical hole in the ground. The very hard seeds and the surrounding endocarp were usually discarded, as they were

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too difficult to grind and represented only about 10 percent of each pod. Water was sprinkled onto the meal, layer by layer, a process that hardened the ground meal with its high sugar content into a firm, dry cake. The next day the women would remove the cakes from the hole.[10] These cakes served as the long-term-storage form of the pods. Pieces were broken off and used for daily food preparation; they also served as dry rations for men going out to hunt. Mesquite pods were primarily a source of carbohydrates, with protein coming from small mammals, birds, and fish.

The importance and preparation of the mesquites of South America—collectively comprised of the botanical species of *Prosopis alba*, *P. chilensis*, *P. flexuosa*, and *P. nigra*—were highly similar to those of North America.[11] Some South American mesquites grow much larger than their North American relatives, attaining trunk diameters of six feet, heights of fifty feet, and canopy diameters of fifty feet. The small branches of these trees provided firewood, while the pods were used for human and animal food. The canopy offered necessary shade, and the nodules on the root system of this leguminous tree enriched the soil to the benefit of crops growing beneath it.

The mesquite tree was so important to the indigenous peoples that it was known in the Quechua language as *taco*, a word subsequently translated into Spanish as *El Arbol*, meaning simply "The Tree."[12] When the Spanish arrived in Central America, the sweet pods with their high sugar content reminded them of their native carob (*Ceratonia siliqua*), called *algarrobo* in Spanish, a name that eventually came to represent the *Prosopis* throughout almost all of South America. *Patay* cakes were made by grinding and sieving the pods of sweet *algarrobo* into a flour that was then sprinkled with water, shaped into cakes, and left to dry. Such cakes are still routinely available in bus stations and food shops in many areas of northwestern Argentina.[13] Beverages were also made from the *algarrobo* pods. A nonfermented drink called *anapa* was prepared simply by grinding pods with water and straining out the pulp, while lightly fermented *aloja* was made from a mash of the dried flour and water.

In the coastal deserts of Peru, a different species of *Prosopis*, *P. pallida*, has been used for millennia. A molasses-like product known as *algarrobina* is made from the boiled-down pods. This thick syrup is widely used for a refreshing cocktail composed of one large cup of milk, one-half cup of *algarrobina* syrup, six jiggers of *pisco* (a type of grape brandy), four small packets of ground cinnamon, and four eggs. The mixture is beaten and served over ice.

Mesquite was also an important plant for the indigenous people in arid regions of northern Mexico and for the settlers who arrived there later.[14] As late as 1965, approximately forty thousand tons of mesquite pods were collected annually in Mexico for use as animal feed. Although by the mid-twentieth century mesquite was no longer a staple food for humans, it is still utilized in minor ways in candies, cookies, and bread.

Thousands of miles away in India, the sweet pods of the native mesquite, *Prosopis cineraria* (also known as *khejri*), were widely collected and used for food. It is not known precisely when people first began to gather the pods, but references to the tree appear in early Sanskrit writings.[15] While slightly more than 50 percent of India is semiarid or arid, the native *khejri* mesquites were concentrated in the Rajasthan Desert in northwestern India. These mesquites were used for human food and livestock forage and to increase crop yields of millet and sorghum, and because of their importance they were revered. One story tells that in 1767, when the maharaja of Jodhpur ordered *khejri* trees felled to fuel furnaces producing lime for a new palace, hundreds of members of the Vishnoi sect fell under the axes of government workers rather than let their beloved trees be chopped down. The maharaja eventually repealed the order and decreed that no more trees be harvested.[16] Today, among the Vishnoi sect, the mesquite tree is still considered holy and is portrayed on the flag with arms of the Indian state of Bikaner.

Farmers in India today tend *khejri* mesquites in their millet and sorghum fields to increase soil fertility. In the winter women are the ones who generally climb to the tops of these trees to prune the leafy, high-protein leaves and branches to feed their livestock. While the *khejri* pods are smaller than those of the mesquites in the western hemisphere, researchers at both the Central Arid Zone Institute in Jodhpur and the National Arid Zone Horticulture Center in Bikaner are working to develop strains that will produce larger pods better suited for human consumption.

In the late 1970s scientists throughout the world took renewed interest in developing the mesquite tree. They conducted genetic studies aimed at accelerating the growth rate, maximizing sugar and protein content, and increasing the trees' ability to withstand adverse soil conditions like high pH and salinity. In Albany, California, Robin Saunders's research group at the United States Department of Agriculture contributed the most important research regarding the use of mesquite for human consumption. They developed dry milling techniques to produce four "fractions" or

Right: *Pods of* khejri (Prosopis cineraria) *on sale in the market. Bikaner, India.*
PHOTOGRAPH BY PETER FELKER © 1998

batches high in fiber, sugar, protein, and gums. Saunders also facilitated a collaborative project with Daniel Meyer at the University of Zurich, who found ways to improve bread making by using nongluten flour from *Prosopis* containing guar gum and who experimented with extrusion techniques to produce thin, snack-type chips and breakfast-cereal flakes.[17] Meyer's panel of taste testers displayed a clear preference for chips made with 10 to 20 percent mesquite flour over those made entirely with corn flour. In addition, Meyer found that the propensity of whole-wheat flours to grow rancid could be reduced fivefold when they are mixed with 20 percent mesquite flour, a discovery that suggests the presence of antioxidants in mesquite flour. Meanwhile, food scientists Nora Grados and Gaston Cruz at the Universidad de Piura in northern Peru expanded upon many of the human-food applications for mesquite flour and the concentrated syrups derived from the pods.[18] Collaborative work between Argentine and Peruvian food scientists suggested that *Prosopis* flour will likely be used for its cinnamon-mocha aroma and taste rather than for its structural properties. They found the optimum concentration of the flour for pastries and granola bars to be in the range of 12 to 18 percent.

In the late 1990s scientific trials in Argentina and Peru confirmed local observations that some wild mesquite trees have bitter, unpalatable pods while others produce sweet, edible pods. Cuttings were taken from the elite trees identified in the field trials and then propagated. The resulting trees, genetic clones of the originals, produced sweet, edible pods. This process could prove valuable for some of the world's poorest regions.[20] For instance, in the harsh deserts stretching from Senegal to Somalia and across the Red Sea to the Arabian Peninsula and India/Pakistan, a variety of *Prosopis* with bitter, inedible pods has already been introduced and thrives; if these undesirable trees were supplanted with selected, preferable strains, mesquite-based food sources could be expanded considerably, and these regions could find new markets for mesquite products.

In 2003 I served as an international consultant for a UN Food and Agricultural Organization *Prosopis*-utilization project in Yemen. During the course of this project, Yemeni scientists conducted an intensive study of the *P. juliflora* trees that had been introduced into the region and found that only one out of seventy-two trees examined had a sweet flavor. However, when 15 percent of flour derived from these sweet trees was mixed with wheat flour, the resulting flatbread was superior in aroma, taste, and color to bread made from wheat flour alone. I recently collaborated with Kenyan scientists working to identify mesquite with sweet pods, which may be used to replace the bitter *Prosopis* trees now common there.

In India similar efforts to introduce trees with sweet pods are being planned by Dr. Gurbachan Singh, assistant director general of the Indian Council for Agricultural Research. *Prosopis juliflora*, the species of mesquite now common in arid and semiarid areas, is a valuable source of firewood in this heavily populated region, but its pods are bitter and inedible. Although the *khejri* trees (*P. cineraria*) do have sweet pods, they grow slowly in comparison to other mesquites. Complementing these two species with trees that have been selected from Peru for their edible properties could have as significant a humanitarian impact in India as in Africa. Erect thornless trees from Peru with potential for human food have also been selected from field trials in Haiti, where *Prosopis* is the most important source of energy.[21]

Expanding the use of mesquite flour in the international culinary community could prove beneficial in two respects: First, the distinctive cinnamon-mocha-coconut aroma and flavor of the flour could lend an exciting taste to pastries and other baked goods. More importantly, increased demand for mesquite flour could catalyze sustainable economic development in some of the world's most impoverished regions where mesquite grows, resulting in jobs, the protection of native mesquites, the cultivation of new species, and the preservation of culturally distinct methods of growing and harvesting *Prosopis*.

NOTES

Mesquite flour can be obtained from Casa de Fruta in Hollister, California. Mail order at 1.800.543.1702 or www.casadefruta.com. The company imports flour from Argentina that is produced by the diocese of Anatuya, one of Argentina's poorest, with help from food science professor Dante Prokopiuk in Saenz Pena, Argentina, and myself. Through this project the diocese aims to use sustainable indigenous local resources to generate economic development in this very depressed region.

1. The pods contain about 10 percent protein and 10 to 40 percent sucrose. See P. Felker, N. Grados, G. Cruz, and D. Prokopiuk, "Economic Assessment of Production of Flour from *Prosopis alba* and *P. pallida* Pods for Human Food Applications," *Journal of Arid Environments* 53 (2003): 517–523.

2. The hard, dense wood of mesquite provides the major source of energy in Haiti. It is also the major firewood species in arid parts of India, the major high-end furniture timber in Argentina, and the premier wood used for barbecue flavoring in the United States. See papers from an international symposium held at the US National Academy of Sciences in Washington, D.C., www.udep.edu.pe/upadi/, *Prosopis* workshop, 2004.

3. Willis H. Bell and Edward F. Castetter, "The Utilization of Mesquite and Screwbean by the Aborigines in the American Southwest," *University of New Mexico Press Biological Series* 5 (1937): no. 2.

4. Ibid.

5. W.H. Bell and E.F. Castetter, "Wild Plant and Animal Products," *Yuma Indian Agriculture* (Albuquerque: University of New Mexico Press, 1951), 179–189.

6. These anthropologists include David Prescott Barrows, who lived with the Cahuilla Indians in the late 1800s and wrote his doctoral thesis on the ethnobotany of the Cahuilla Indians at the University of Chicago in 1900. See D.P. Barrows, "The Ethnobotany of the Coahuilla Indians of Southern California"

(Ph.D. diss., University of Chicago, 1900 [reprinted by Malki Museum Press, Morongo Indian Reservation, Banning, California, 1977]). See also the definitive work of the ethnobotanists Willis Bell and Edward Castetter of the University of New Mexico, cited in notes three and five above; and John Lowell Bean and Katherine Siva Saubel, *Temalpakh Cahuilla Indian Knowledge and Usage of Plants* (Banning, CA: Malki Museum Press, 1972), 223. Richard Felger from the Drylands Institute in Tucson, Arizona, worked with the Seri Indians in Baja, California, and found mesquite to be the most important food source out of more than two hundred plant species. See R. Felger and M. Moser, "Seri Indian Food Plants: Desert Subsistence without Agriculture," *Ecology Food Nutrition* 5 (1976): 13.

7. Barrows, Castetter and Bell, and Bean and Saubel all concur that mesquite pods were perhaps the most important human food among the Indian tribes of the American Southwest.

8. For the results of replicated field trials of the mesquites of both Argentine and Peruvian origin, see P. Felker, C. Lopez, C. Soulier, J. Ochoa, R. Abdala, and M. Ewens, "Genetic Evaluation of *Prosopis alba* (*algarrobo*) in Argentina for Cloning Elite Trees," *Agroforestry Systems* 53 (2001): 65–76; and L. Alban, M. Matorel, J. Romero, N. Grados, G. Cruz, and P. Felker, "Cloning of Elite, Multipurpose Trees of the *Prosopis juliflora/pallida* Complex in Piura, Peru," *Agroforestry Systems* 54 (2002): 173–182.

9. Photographs of wicker baskets can be found in Bean and Saubel, *Temalpakh Cahuilla Indian Knowledge*.

10. According to Bell and Castetter in "The Utilization of Mesquite and Screwbean," the cakes were eighteen inches long, twelve inches wide, and ten inches thick.

11. Their importance was discussed by the late Arturo Burkart, an esteemed Argentine botanist from the Darwinian Institute of Botany in Buenos Aires, and his protégé, Otto Solbrig, former curator of the herbarium at Harvard University. See H.L. D'Antoni and O.T. Solbrig, "Algarrobos in South American Cultures Past and Present," *Mesquite: Its Biology in Two Desert Ecosystems*, B.B. Simpson, ed. (Stroudsburg, PA: Dowden, Hutchinson and Ross, 1977), 189–199.

12. Ibid.

13. Personal observations by the author.

14. F.G. Lorenzo, "La importancia de mesquite y huisaches en los estados de México," *Mezquites y Huisaches* (Mexico, D.F.: Ediciones del Instituto Mexicano de Recursos Naturales Renovables, A.C., 1965), 57.

15. H.S. Mann and S.K. Saxena, "Khejri. *Prosopis cineraria* in the Indian Desert. Its Role in Agroforestry," CAZRI monograph, vol. 11 (Jodhpur, India: Central Arid Zone Research Institute, 1980), 78.

16. www.edugreen.teri.res.in/explore/forestry/bisnoi.htm.

17. D. Meyer, "Processing, Utilization and Economics of Mesquite Pods as a Raw Material for the Food Industry" (Ph.D. diss., Swiss Federal Institute of Technology, ETH 7688, 1984), 159.

18. See N. Grados and C. Cruz, "New Approaches to Industrialization of Algarrobo (*Prosopis pallida*) Pods in Peru," at www.udep.edu.pe/upadi/, *Prosopis* workshop, 2004, 3.24–3.42.

19. Since *Prosopis* flour does not contain gluten, it cannot be used like wheat flour to increase volume. Neither does it have any protein advantages over other flours. Therefore food scientists believe that its most important use will be as a kind of "sweet spice" to add flavor and aroma to baked goods. See Felker et al., "Economic Assessment of Production of Flour."

20. For a description of the current distribution of bitter *Prosopis* pods and the areas to which new genetic materials with highly sweet pods appropriate for human use are adaptable, see Felker et al., "Genetic Evaluation of *Prosopis alba*," and Alban et al., "Cloning of Elite, Multipurpose Trees."

21. For details of the selection process for the erect thornless Peruvian clones with potential for food use in Haiti and a general discussion of deforestation issues, see T. Wojtusik, P. Felker, E.J. Russell, and M.D. Benge, "Cloning of Erect, Thornless, Non-browsed Nitrogen Fixing Trees of Haiti's Principal Fuelwood Species (*Prosopis juliflora*)," *Agroforestry Systems* 21 (1993): 293–300.