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PINE NUTS AS AN ABORIGINAL FOOD SOURCE IN CALIFORNIA AND NEVADA: SOME CONTRASTS

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ABSTRACT.—Seeds of a large number of western species of the genus *Pinus* have been used by the native peoples of the southwestern and Pacific Coast states as food. A sense of uniformity of the food value across species has been engendered by the use of the common term *piñon* to describe pine seeds (colloquially, "nuts"), regardless of species. In fact, a wide variation exists in their food values, especially between the major edible species. The difference is particularly striking in comparing the single-leaf piñon *(Pinus monophylla)* of the Great Basin with the gray or digger pine *(P. sabiniana)* of the Central Valley foothills of California. Each of these species occupies a discrete, non-overlapping territory. However, the level of importance as a food item varies between the Great Basin peoples, for whom *P. monophylla* was a staple, and the California Indians who considered *P. sabiniana* the source of a highly desirable, if incidental, food item.

INTRODUCTION

When the Spanish explorers traveled through the south Coast Ranges of California in the late 18th century, they met Indians along the way who offered them a variety of foods. For the most part these foods were new to the Spaniards, however, one was very familiar, *piñones,* the seeds of the pine trees. One explorer wrote in 1775 concerning these *piñones,* "There are many pine nuts like those of Spain" and, "In the mountains there are seen many pines like those of Spain" (Fages 1937:59, 35). Presumably these pines were either *P. sabiniana* Dougl. (the digger or gray pine) or *P. coulteri* D. Don (the Coulter or big-cone pine). *Pinus sabiniana* would be the better candidate since its notably hard-shelled "nut" (actually seed) would have been the most similar to the piñon of Spain, the seed of *P. pinea* Linn., the Italian stone pine.

The Spanish encountered pine trees and their seed in a number of other places, particularly in the American Southwest (Lanner 1981; Long 1941) and so the term piñon has become commonly attached to the seeds of a number of species of pine. Since there is such concern among botanists over the use of the correct term, seed, versus the colloquial term, nut, the Spanish word piñon forms a nice ambivalent compromise.

When the word piñon (or pinyon) is used it usually means the seed of *P. monophylla* Torr. & Frem. (single-leaf piñon), *P. edulis* Engelm. (New Mexico piñon), or *P. cembroides* Zucc. (Mexican piñon). However, the term is also applied to the seed of a number of other species of pine which causes a certain degree of confusion. This is particularly true in publications listing nutritional values of American foods. These will generally list pignolia and piñon as the two forms of pine nuts (Watt and Merrill 1963:46; Adams 1975:123; Pennington and Church 1980:108). Pignolia clearly refers to the Mediterranean species, *P. pinea.* When the term piñon is used, it is very unclear, although an examination of the nutrient content seems to narrow it down to *P. edulis* or possibly *P. cembroides* (cf., Botkin and Shires 1948:9).

This tendency to use the term "pine nuts" or piñon with no attempt at specification does not present a problem when there is only one species of pine bearing edible seeds found in an area. However, in California there are no less than seven species with edible seeds. The California Indians exploited *P. sabiniana, P. lambertiana, P. ponderosa, P. coulteri, P. monophylla, P. quadrifolia,* and *P. torreyana* for their seeds (Yanovsky 1936:5-6).

Whereas most of the Indian peoples of California used the pine seed for food (Farris 1982), its importance is largely overshadowed by the acorn. However, the case is quite different for the Indians of the Great Basin for whom the seed of *P. monophylla* was of

major importance (Steward 1941:230). Paiute families in the Great Basin would establish their fall encampments near a producing stand of *P. monophylla* and, if the harvest were particularly good, might actually remain in the vicinity through the winter despite the relatively high elevation favored by this species (Steward 1938:232; Bettinger 1976:83).

Although it may be supposed that pine seeds of varying species are similar in their nutritional qualities as well as their availability, this is not the case. In fact, it has been stated:

> This wide and unexpected variation [in nutritional component proportions] between the different species of pine nuts suggests that, if all other commercial nuts were no longer available, their nutrients in any proportion could be supplied by some species of pine nut (Botkin and Shires 1948:12).

With this in mind I would like to turn attention to two particular species which differ radically in many of their physical and nutritional qualities: the *Pinus sabiniana* of California and the *Pinus monophylla* of the Great Basin (Fig. 1). It should be noted that *P. monophylla* is by no means limited to the Great Basin since it appears through the Transverse Ranges of southern California and on down into Baja California (Barrows 1971:310-311; Bean 1972:40; Zigmond 1941:30-32). However, it primacy as a subsistence item occurred in the Great Basin.

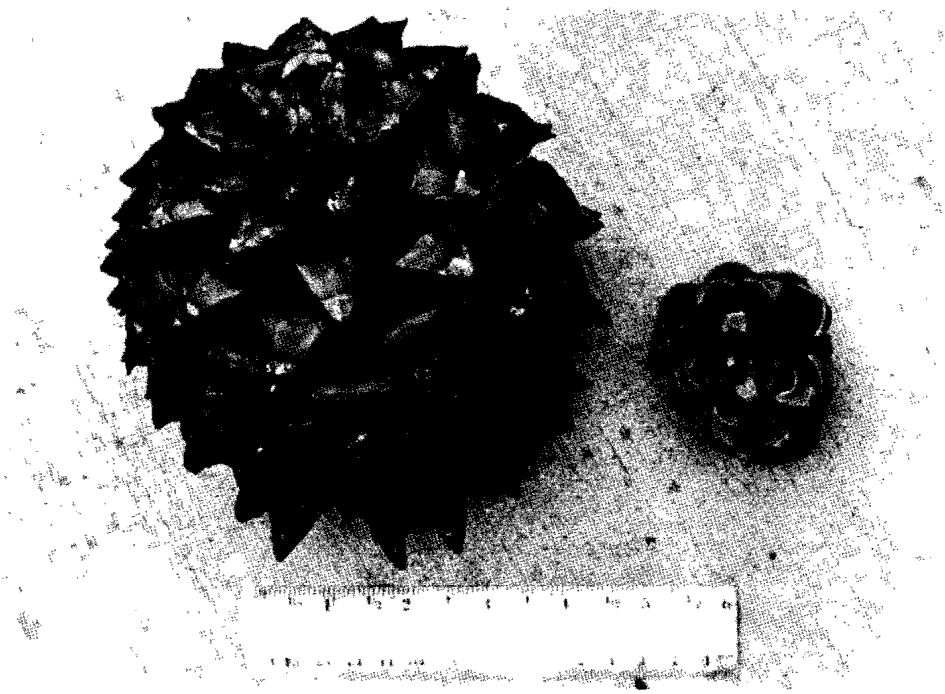

FIG. 1—Cones of *P. sabiniana* (left) and *P. monophylla* (right).

PINUS SABINIANA

This species is most often associated with an environment of grassland and/or chaparral-covered hillsides typical of the foothill regions of the Sierra Nevada and the Coast Range areas of California. It survives well on poor soils such as the serpentinite soils of the Coast Range (Griffin 1965; Jepson 1910:88). It often shares an environment with manzanita *(Arctostaphylos* spp.) and blue Oak *(Quercus douglasii),* both of which were important as food sources for the California Indians.

When mature, *P. sabiniana* trees may grow from 15-25 m high. The interval between large seed crops is said to be 2-4 years on the average. It takes two years for a cone to produce mature seeds (USDA 1974:609, 611). The cones are large, usually ranging from 10-25 cm in length and often produce over 100 seeds each. It is important to remember that not all of the seeds have developed kernels. The variation from cone to cone can be quite remarkable in terms of size (Griffin 1964). Kernel weight averages 195 mg (Farris 1982; Griffin 1962).

For this study seeds were obtained from 26 cones collected by the author in the Sierra Nevada foothills and the Coast Range. The cones were split apart and the seeds gathered, counted, and separated into those with developed kernels and those with undeveloped kernels. It is fairly easy to separate the seeds with developed kernels. When the seeds are placed in water, the filled seeds sink whereas those with undeveloped kernels float (Griffin 1962:135; USDA 1974:621). Table 1 shows the results of this investigation.

TABLE 1.—*Seed production of 26* P. sabiniana *cones.**

Cone No.	Total seeds	seeds with developed kernels	seeds with undeveloped kernels
1	137	126	11
2	149	146	3
3	61	4	57
4	137	116	21
5	188	88	100
6	166	58	108
7	111	85	26
8	84	76	8
9	107	72	35
10	186	182	4
11	128	109	19
12	101	85	16
13	92	69	23
14	75	39	36
15	61	41	20
16	74	65	9
17	99	82	17
18	100	87	13
19	79	55	24
20	64	41	23
21	156	111	45
22	162	141	21
23	119	119	0
24	79	69	10
25	113	78	35
26	114	99	15
	X = 113.15 S.D. = 37.8 Range—61-188	X = 86.26 S.D. = 38.4 Range—4-182	X = 38.96 S.D. = 69.56 Range—0-108

*The above cones were obtained from the Sierra Nevada foothills just east of Sacramento and from the Coast Range immediately west of Sacramento on October 13 and 20, 1981. (Herbarium Voucher, Farris 94907, DAV).

Indian people often maximized their efforts by sampling a few cones from a tree before settling down to collect the cones in earnest. This practice is illustrated in some folklore of the Yana and Wintu Indians of the Northern Sacramento Valley. When gathering pine cones the climber would throw down a few from the tree and then ask, "Are the nuts good?" or, "Are the nuts big?" If given an affirmative answer he would continue (Sapir 1910:123-124; DuBois and Demetracopoulou 1931:339-340). Therefore, the averages of 113 seeds per cone and 86 seeds with developed kernels per cone (Table 1) include some cones which would probably have been rejected by the Indians.

The difficulty with collecting digger pine cones is that they usually adhere firmly to the branches and often need to be twisted off by hand. This usually required climbing the trees and such climbing was normally done by men. By contrast, processing of the cones was undertaken by the women (Willoughby 1963:28-29). It is not sufficient to wait for the cones to drop because they only do so after opening their scales while still attached to the tree and scattering the seed over a period of several months. The cone may remain on the tree for as much as seven years after shedding the seed (Jepson 1910: 87). Competition with animals made it advisable to pick the cones before they were ready to open on their own. They were then heated to remove the bothersome pitch and also to get the cones to open somewhat to facilitate the removal of the seeds.

The seeds could be eaten raw, but were commonly roasted either in the cone or in parching trays. In addition they were often ground up into a meal to be boiled as a pine nut soup or baked into a bread. If stored for more than a year the high fat content would cause the seeds to become rancid.

PINUS MONOPHYLLA

In many ways *P. monophylla* forms a striking contrast to *P. sabiniana.* The cone is comparatively tiny, often only 5-8 cm high (Fig. 1). There are only 10-20 seeds in an average cone. The trees are much smaller and more accessible, usually not more than 8 m high. They are found in southern Idaho, Utah, Arizona, California and Baja California. Their range of elevation is generally above 1200 m (Sudworth 1908:35-37; Critchfield and Little 1966:9, 48). The interval between large seed crops is 1-2 years (USDA 1974:611).

The seeds are often quite large and have a high kernel-to-shell ratio. In samples measured by the author the kernel averaged 72-77% of the total weight of the seed while the shell averaged 23-28%. The average kernel weight was 270 mg. The thin shell meant that it was very easy to hull the seeds. Although water flotation is not effective in separating the seeds with developed kernels from those with undeveloped ones, there is a clue in the coloration of the seeds. The dark seeds tend to have the developed kernels while the undeveloped seeds are usually a tan color (Lanner 1981:48).

Indian people obtained the cones by knocking them down with a stick or shaking the tree. As in the case of *P. sabiniana,* men would usually knock the cones off the tree and then the women would collect them and process them (Steward 1941:312-313). However, in an eyewitness account from 1891, the women knocked down the cones, collected them, and processed them (Dutcher 1893:378-379).

Once the cones were down they were heated to open them since they were usually collected prior to full ripening. The seeds could be hulled by rolling them on a flat stone (metate) using a handstone (mano). It appears that even the hulls were eaten in some cases since they were present in human coprolites (fossilized feces) found in southern California desert archaeological sites (Wilke 1978:79). For storage the seeds were cleaned of the chaff and dirt through winnowing and then packed in baskets or, in later times, in cloth gunnysacks.

NUTRITIONAL COMPARISON

Dramatic differences are to be found in nutritional data on the seeds of *P. monophylla* and *P. sabiniana.* Considering three major constituents: protein, carbohydrates

and fats, these two species differ significantly. Whereas seeds of *P. sabiniana* have over 25% protein, those of *P. monophylla* have under 10%. On the other hand, *P. monophylla* seeds have over 50% carbohydrate as against a figure below 20% for those of *P. sabiniana* having about 50% fat and *P. monophylla* having only 23% (Table 2).

The amino acid content of the protein found in each species is shown in Table 3. The most limiting amino acid, i.e., the amino acid in least concentration, is determined by means of a scale of "chemical scores." The amino acids are compared against an ideal protein using the formula:

$$\text{Chemical Score} = \frac{\text{mg of A.A. in 1 g. of test protein}}{\text{mg of A.A. in ideal protein}} \times 100$$

The "ideal protein" figures were developed to replace specific foods such as human milk and whole egg which had been used in previous chemical or amino acid score calculations (FAO/WHO 1973:62-64). It is therefore necessary to determine the source of data for the calculations of chemical scores found in other published materials so as not to make erroneous comparisons (e.g., Benson et al. 1973:146; Kaldy et al. 1980:356).

The overall protein score is derived from the score of the most limiting amino acid. This is due to the necessity that "all amino acids must be present at the site of protein synthesis in adequate amounts for protein synthesis to proceed, an equal percentage deficit of any essential amino acid would limit protein synthesis to a comparable degree" (FAO/WHO 1973:62).

The protein scores for *P. sabiniana* and *P. monophylla* found in Table 3 show that lysine is the most limiting amino acid in both species. This is a common finding for plant protein with some exceptions (e.g., legumes). *P. monophylla* ranks considerably higher than *P. sabiniana* in each of the other amino acids with the exception of the sulphur-containing ones (methionine and cystine).

The fat in *P. sabiniana* is composed of 4.3% saturated fatty acids, 50.5% oleic acid (monounsaturated) and 45.2% linoleic (polyunsaturated) acid (Semb 1935:610). *P. monophylla* fat is 85% composed of unsaturated oleate, linoleate, and linolenate acids (Lanner 1981:102; cf. Adams and Holmes 1913).

Although the fiber content was not determined for *P. sabiniana*, it is apparent from Table 2 that crude fiber is generally quite low for pine seeds. The low 1.1% figure for *P. monophylla* would have been substantially increased on occasions when the shells were eaten along with the kernels. However, the hard shell of the digger pine seed would have precluded such a possibility for this species.

The ash content of digger pine is shown to be nearly twice that of *P. monophylla*, although quite comparable to several other pine species (e.g., *P. pinea* and *P. lambertiana*). *P. monophylla* resembles more its Southwest neighbor, *P. edulis*, in this regard. The mineral content shows higher levels for *P. sabiniana* in calcium, iron, manganese and zinc (Table 2).

The energy value of 100 g of *P. sabiniana* is substantially higher than *P. monophylla*, mainly due to the high fat content. The caloric content places *P. monophylla* more on a par with acorn meal than with any of the other pine species shown (Table 2).

CONCLUSION

In discussing the two most highly contrasting species of pine seeds it is clear that there exists a large inter-species variation. This is important to consider when one sees broad generalizations made about pine nuts or piñons. *Pinus monophylla* has been particularly subject to erroneous reporting in the past (see Farris 1980), although a recent author seems better informed (Lanner 1981).

Although *P. monophylla* has had some local commercial success as the source of a cash crop, this has not occurred in the case of *P. sabiniana*, despite the great success of

TABLE 2.—*Nutritional Values of Some Pine Seeds and Acorn Meal.*

Species	Water	Prot.[a]	Fat	Carb.[b]	Fiber[c]	Ash	Kcal/100 g.[d]	Mineral Content[e] (mg/100 g E.P.			
	(grams/100 grams Edible Portion)							Ca	Fe	Mn	Zn
P. sabiniana[f]	3.6	25.0	49.4	17.5	—	4.5	571	5.1	8.4	4.4	13.0
P monophylla[g]	10.2	8.1	23.0	56.3	(1.1)	2.4	450	1.0	1.9	1.3	2.9
P. *pinea*[h]	5.6	31.1	47.4	11.7	(0.9)	4.3	552	14.0	4.4	—	—
P. edulis[g]	3.0	12.0	60.9	21.4	(1.1)	2.7	638	12.0	5.2	—	—
P. lambertiana[f]	3.3	21.4	53.6	17.5	—	4.2	594	4.5	6.7	16.4	7.6
Quercus kelloggii (meal)[i]	11.3	3.8	19.8	64.8	(2.1)	0.3	443	—	—	—	—
Quercus lobata (meal)[i]	8.7	4.8	18.6	65.9	—	2.0	440	—	—	—	—

a. Protein calculated using a 5.3 multiplier for N. (Jones 1931:13; Watt and Merrill 1963:161).

b. Total Carbohydrate figure including Fiber.

c. Crude fiber, absence from table means not calculated.

d. Kcal = g prot. x 3.47 + g carb. x 4.07 + g fat x 8.37 [calculated per 100 g E.P.] (Watt and Merrill 1963:160).

e. Mineral content for *P. sabiniana, P. monophylla* and *P. lambertiana* calculated by Carl Keen, UC/Davis using dry-ashing method (Clegg et al. 1981).

f. Farris 1982.

g. Botkin and Shires 1948

h. Anonymous 1963; Watt and Merrill 1963:46.

i. Merriam 1918.

TABLE 3.—*Amino Acid Composition and Chemical Scoring of Seeds of* P. sabiniana *and* P. monophylla.[a]

Essential Amino Acids[b]	Ideal Prot.[c]	Pinus sabiniana			Pinus monophylla		
	mg AA/g Prot.	mm AA/g N.	mg AA/g Prot.[d]	Score[e]	mg AA/g N.	mg AA/g Prot.[d]	Score[e]
Isoleucine	40	145	27	68	213	40	100
Leucine	70	306	58	83	400	75	>100
Lysine	55	125	24	44	123	23	42
Methionine + cystine[f]	35	140	26	74	131	25	71
Phenylalanine + tyrosine[f]	60	343	65	>100	398	75	>100
Threonine	40	123	23	58	188	35	88
Valine	50	233	44	88	281	53	>100
Protein Scores				44			42

a. Farris 1982

b. Only 7 of 8 essential AA determined. Tryptophan lost in hydrolysis of protein sample.

c. FAO/WHO 1973:63

d. $\frac{\text{mg AA/g N.}}{5.3}$ = mg AA/g Prot. for nuts (Jones 1931:13; Watt and Merrill 1963:161).

e. Chemical or Amino Acid Score = $\frac{\text{mg AA in 1 g. test prot.}}{\text{mg AA in ideal prot.}}$ X 100 (FAO/WHO 1973:63).

f. Amino Acids cystine and tyrosine are included because of their sparing action on methionine and phenylalanine respectively.

the very similar Mediterranean species *P. pinea*, the pignolia (Farris n.d.). Indian people had shown great interest in the seeds of both *P. monophylla* and *P. sabiniana*, although the former took on more the quality of a staple food whereas the latter was used mainly as a special treat.

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