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RESEARCH ARTICLE

Early coconut distillation and the origins of mezcal and tequila spirits in west-central Mexico

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Abstract No evidence exists of distillation in Mexico before European contact. The Philippine people in Colima established the practice in the 16th Century to produce coconut spirits. Botanical, toponymic, archaeological, and ethnohistoric data are presented indicating that agave distillation began in Colima, in the lower Armería-Ayuquila and Coahuayana-Tuxpan river basins, using *Agave angustifolia* Haw. and through adaptation of the Philippine coconut spirits distillation technique. Subsequent selection and cultivation of agaves led to their domestication and diversification. This did not take place in the lower river basins, where agave populations tended to disappear. The distillation technique spread to the foothills of Colima volcanoes and from there to all of western Mexico, leading to creation of tequila and other agave spirits. Two factors aided producers in avoiding strict Colonial prohibitions and were therefore key to the diffusion and persistence of agave spirits production: (1) clandestine fermentation in sealed, underground pits carved from bedrock, a native, pre-European contact technique; and (2) small, easy-to-use Philippine-type stills that could be hidden from authorities and allowed use of a broad range of agave species.

Keywords *Agave angustifolia* · *Cocos nucifera* · Diversification · Domestication · Genetic resources · Mexico · Mezcal · Tequila

Introduction

With 200 species, the *Agave* genus is the largest of the Agavaceae family. Its center of origin and diversity is Mexico, where 150 species (75%) are distributed, 116 (58%) of which are endemic (Gentry 1982; García-Mendoza 2003). Before corn (*Zea mays* L.) became a staple crop, agaves were the main carbohydrate source for the native populations of what are today western Mexico and the southeast United States of America. They were eaten by first cooking the stems and floral peduncles in stone ovens (Callen 1965; Smith 1986; Hodgson 2001). In western Mexico, cooked agave stems and floral peduncles were also used to produce nutritionally and culturally important beverages, whereas in central Mexico beverages were made of fresh agave sap from cuts in the floral peduncle (Bruman 1940, 2000; Parsons and Parsons 1990; Nobel 1994; Parsons and Darling 2000).

Dedicated to Henry Bruman in honor of his contribution to the understanding of coconut and agave genetic resources history in America.

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Production of spirits from fermented coconut and agave became an economically significant activity in western Mexico in the 17th and 18th centuries, in response to the advent of mining in northern and central Mexico (Luna-Zamora 1991; Zizumbo-Villarreal 1996). The resulting competition with grape-based spirits imported from Spain led to prohibition of the production and sale of coconut and agave spirits. Coconut spirits consequently disappeared and agave spirits were then produced clandestinely in remote areas far from the influence of Colonial authorities (Sevilla del Río 1977; Walton 1977; Burwell 1995; Zizumbo-Villarreal 1996). Legalization of agave spirits production in the mid-19th century, in addition to increasing international demand for agave spirits (particularly tequila, made in Tequila, Jalisco) in the late 19th century and throughout the 20th century, has since returned it to being the most significant economic activity in western Mexico (Luna-Zamora 1991; Valenzuela-Zapata and Nabhan 2003).

There are currently diverse types of agave spirits produced in Mexico, differentiated by the species used and the traditional features of the cooking, fermentation and distillation processes. Colunga-GarcíaMarín (2006) has reported 43 species use to elaborate these drinks. They commonly receive the generic name "mezcales," but agave spirits can receive about 80 different regional names because of their different features. A Denomination of Origin (DO) has been recognized to some of them, as the DO "tequila" for the "mezcal" produced with *Agave tequilana* Weber grown in the states of Jalisco, Nayarit, Michoacán, Guanajuato, and Tamaulipas; the DO "mezcal" for the agave spirits produced with *A. angustifolia* Haw., *A. asperrima* Jacobi, *A. weberi* Cela, *A. potatorum* Zucc., *A. salmiana* spp. *crassispina* (Trel.) Gentry, and any other species grown for this purpose in the states of Durango, Guanajuato, Guerrero, Oaxaca, San Luis Potosí, Tamaulipas, and Zacatecas, and that it is not in any other DO; and the DO "bacanora" for the "mezcal" produced with *A. angustifolia* in the state of Sonora. Traditional production processes of these and other spirits made by distilling the ferments of cooked agave stems have been documented by Gentry (1982), Burwell (1995), Valenzuela-Zapata (1997), García-Mendoza (1998, 2003), Granados-Sánchez (1999), Aguirre-Rivera et al. (2001), Espinosa-Paz et al. (2002), Colunga-GarcíaMarín (2006), among others.

No archaeological or historical evidence are available for the suggestion of Bourke (1893) and Lumholtz (1902) for the existence of distillation in Mexico before European contact. There are two hypotheses about the origins and distillation of agave spirits. Bruman (1944a, 1945) proposed that agave distillation and spirits production originated during the late 16th Century in the state of Colima with the introduction and adaptation of Philippine technology used to produce spirits from coconut (*Cocos nucifera* L.). Other authors (Luna-Zamora 1991; Valenzuela-Zapata 1997; Valenzuela-Zapata and Nabhan 2003), however, have claimed it originated during the early 17th Century in the Tequila Valley, Jalisco, through adaptation of the sugar cane (*Saccharum officinarum* L.) rum technological model and using the Arab type still.

Walton (1977) provided linguistic and historical data that suggest that the origin of the agave spirit later named "tequila" after the town where it became famous, can be traced to the Colima volcanoes region in southern Jalisco, thus supporting Bruman's hypothesis (1944a, 1945). Further supporting Bruman and Walton, Colunga-GarcíaMarín and Zizumbo-Villarreal (2006) reported a greater number of agave cultivars used in agave spirits production in southern Jalisco than in the central Jalisco valleys of Tequila and Amatitán, as well as generalized use of Philippine-style stills. They also suggested that agave spirits distillation in central-west Mexico began in the lower Armería and Coahuayana river basins in Colima. Vargas-Ponce et al. (2007) reported that in the foothills of the Colima volcanoes, *A. tequilana* was used for tequila production, and *A. angustifolia* and *A. rhodacantha* for other traditional agave spirits. They also documented 24 morphologically differentiated, local cultivars that have not yet been taxonomically or agronomically described. These have been selected from wild populations and cultivated by local producers, suggesting that this region is a center of agave diversification and domestication focused on agave spirits production.

Within this context, botanical, toponymic, archaeological and ethnohistorical research was done aimed at answering the following questions: (1) Did agave distillation originate from application of the coconut spirits distillation technique in the lower Armería and Coahuayana river basins of Colima and later spread

to the foothills?; (2) Did agave diversification and domestication begin in the lowlands?; and (3) What characteristics of the production process favored the diffusion and persistence of agave spirits production despite its legal prohibition and competition from imported Spanish spirits?

Methodology

Study area and botanical evidence

Botanical exploration was done from September 2003 to September 2005 following the methods of Hernández-Xolocotzi (1971). This included collection of botanical material and germplasm within the area covered by Colima in the 16th Century, that is, the provinces of Amula, Tuspa, Tepetitango, Coalcomán, Colimotl, and Motín del Oro (Fig. 1) (Sauer 1948). Particular emphasis was placed on sites along the Ayuquila-Armería and Tuxpan-Coahuayana river systems. Botanical samples were deposited in the herbarium of the Centro de Investigación Cientifica de Yucatán (CICY) (Carnevali 2004). Germplasm accessions were placed in the CICY Agave Collection (Colunga-GarcíaMarín 2004) (Table 1).

Toponymic data

Based on the assumption that geographic names indicate the cultural or economic importance given by inhabitants to the referent in the place name, records were made of sites with names related to the agave plant, its uses and products. For example, *mexcatl* or *mezcatl* are Náhuatl words for agave, *ixtle* is the Náhuatl word for agave fiber and *taberna* is the

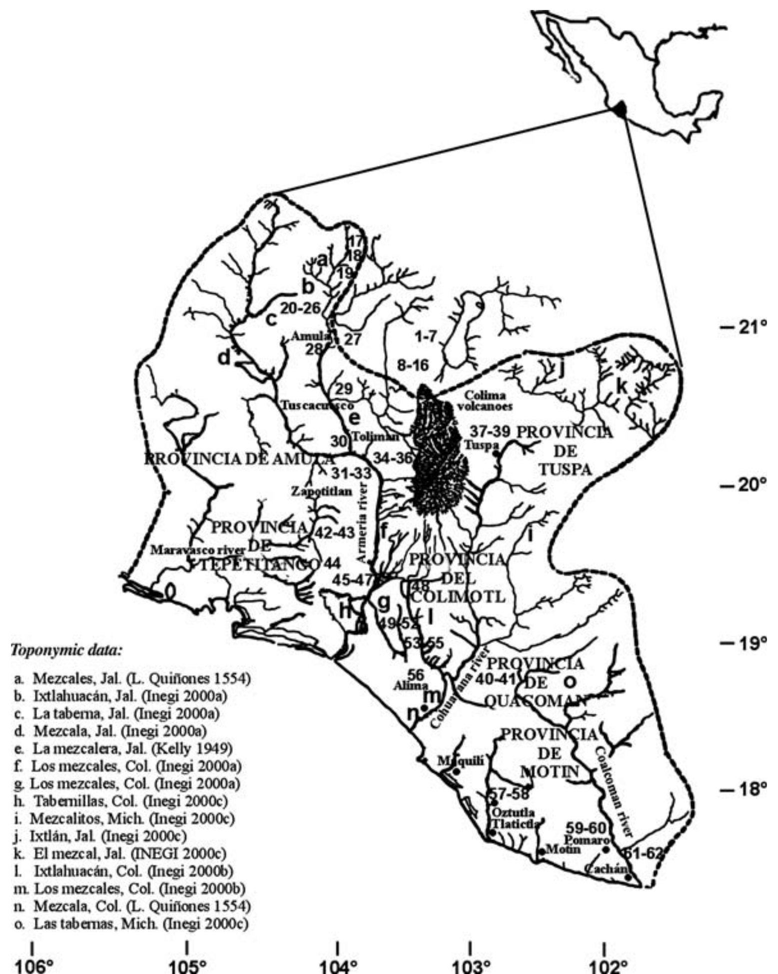


Fig. 1 Territory of Colima in 16th Century (Sauer 1948) showing place names associated with the agave plants or the agave spirits production (mezcal) (Toponymic data: letters), and collection sites for botanical material and germplasm (numbers, see Table 1)

Table 1 Herbarium and germplasm collections: Population, Municipality, State (St); Geographic location: Latitude (Lat), Longitude (Lon), Altitude (Alt); Species (Sp): *Agave angustifolia* (*A*); *A. rhodacantha* (*R*); *A. hookeri* (*H*); *A. colimana* (*C*); Botanic collection number or photographic record (Co/RF), Germplasm accession number (Ac)

No.	Population	Municipality	St	Lat	Lon	Alt	Sp	Col/RF	Ac
1	Sayula 1	Atoyac	Jal	19°57′	103°26′	1013	*A*	1230	1237
2	Sayula 2	Atoyac	Jal	19°57′	103°26′	1013	*A*	1233	1235
3	Sayula 3	Atoyac	Jal	19°57′	103°26′	1013	*A*	1235	1235
4	Sayula 4	Atoyac	Jal	19°57′	103°26′	1013	*R*	1237	1237
5	Sayula 5	Sayula	Jal	19°41′	103°44′	1586	*A*	nc	03170v2
6	Sayula 6	Atoyac	Jal	19°57′	103°36′	1356	*A*	nc	03122
7	Sayula 7	Sayula	Jal	19°57′	103°26′	1013	*A*	3123	nc
8	San Gabriel 1	Sayula	Jal	19°45′	103°42′	1864	*A*	1318	nc
9	San Gabriel 2	Sayula	Jal	19°45′	103°42′	1863	*A*	1319	1319
10	San Gabriel 3	San Gabriel	Jal	19°45′	103°42′	1864	*A*	nc	1362
11	San Gabriel 4	Sayula	Jal	19°45′	103°42′	1863	*A*	nc	1422
12	San Gabriel 5	Sayula	Jal	19°51′	103°36′	1489	*A*	nc	1243
13	San Gabriel 6	San Gabriel	Jal	19°40′	103°46′	1290	*A*	nc	03173 -2
14	San Gabriel 7	San Gabriel	Jal	19°45′	103°42′	1864	*A*	nc	1362
15	San Gabriel 8	San Gabriel	Jal	19°45′	103°42′	1864	*A*	1353	nc
16	San Gabriel 9	San Gabriel	Jal	19°45′	103°43′	1262	*A*	1609	nc
17	Cocula	Cocula	Jal	20°20′	103°53′	1300	*A*	393-2(p)	nc
18	Tecolotlán 1	Tecolotlán	Jal	20°20′	103°53′	1503	*A*	nc	04301
19	Tecolotlán 2	Tecolotlán	Jal	20°16′	103°59	1709	*A*	1619	nc
20	Autlán 1	Autlán	Jal	19°49′	104°19′	1166	*A*	nc	1014
21	Autlán 2	Autlán	Jal	19°39′	104°05′	781	*A*	nc	1126
22	Autlán 3	Autlán	Jal	19°36′	103°54′	872	*A*	nc	03197
23	Autlán 4	Autlán	Jal	19°49′	104°19′	1176	*A*	nc	03351
24	Autlán 5	Autlán	Jal	19°50′	104°19′	1190	*A*	nc	938
25	Autlán 6	Autlán	Jal	19°49′	104°19′	1166	*A*	nc	1000
26	El grullo	El grullo	Jal	19°49′	104°12′	1111	*A*	nc	953
27	Tonaya 1	Tonaya	Jal	19°45′	103°56′	881	*R*	3176	03176
28	Tonaya 2	Tonaya	Jal	19°49′	102°12′	1108	*A*	nc	985
29	Tuxcacuesco	Tuxcacuesco	Jal	19°39′	104°02′	793	*A*	nc	1028
30	Tolimán	Tolimán	Jal	19°36′	103°55′	740	*A*	1401	nc
31	Paso del Real	Tolimán	Jal	19°36′	103°55′	750	*A*	1512	nc
32	Canoas	Tolimán	Jal	19°32′	103°55′	730	*R*	1591	nc
33	Tajipo	Tolimán	Jal	19°32′	103°55′	730	*A*	1589	nc
34	Perempiz	Zapotitlán	Jal	19°32′	103°55′	700	*A*	1547	nc
35	Zapotitlán	Zapotilán	Jal	19°32′	103°49′	952	*A*	04342	nc
36	Zapotitlán	Zapotilán	Jal	19°32′	103°49′	952	*R*	1601	nc
37	Tuxpan 1	Tuxpan	Jal	19°34′	103°50′	1000	*A*	1152	nc
38	Tuxpan 2	Tuxpan	Jal	19°34′	103°50′	1000	*R*	1181	nc
39	Tuxpan 3	Tuxpan	Jal	19°34′	103°50′	1000	*A*	1187	nc
40	Coalcomán 1	Coalcomán	Mich	18°45′	103°10′	1400	*H*	RF	nc
41	Coalcomán 2	Coalcomán	Mich	19°40′	103°08′	1200	*H*	RF	nc
42	Cerro grande	Villa de Álvarez	Col	19°25′	103°58′	600	*A*	2506	2506
43	Cerro grande	Villa de Álvarez	Col	19°25′	103°58′	800	*A*	2507	2507

Table 1 continued

No.	Population	Municipality	St	Lat	Lon	Alt	Sp	Col/RF	Ac
44	Cerro barrigón	Villa de Álvarez	Col	19°13′	103°52′	500	*A*	RF	nc
45	Cerro alcomún	Villa de Álvarez	Col	19°05′	103°50′	600	*C*	nc	2508
46	Cerro alcomún	Villa de Álvarez	Col	19°05′	103°50′	600	*C*	nc	2509
47	Cerro alcomún	Villa de Álvarez	Col	19°05′	103°50′	550	*A*	nc	2510
48	La cumbre	Colima	Col	19°10′	103°40′	550	*A*	2501	2501
49	Las guazimas 1	Colima	Col	19°08′	103°43′	400	*A*	2502	2502
50	Las guazimas 2	Colima	Col	19°08′	103°43′	400	*A*	2503	2503
51	Los Ortices 1	Colima	Col	19°08′	103°43′	400	*A*	RF	nc
52	Las Ortices 2	Colima	Col	19°08′	103°43′	400	*C*	RF	nc
53	La salada	Ixtlahuacán	Col	18°04′	103°45′	300	*A*	2504	2504
54	La salada	Ixtlahuacán	Col	18°04′	103°45′	300	*A*	2505	2505
55	Chamila	Ixtlahuacán	Col	18°57′	103°42′	250	*A*	RF	nc
56	San Gabriel	Ixtlahuacán	Col	18°54′	103°44′	300	*A*	RF	nc
57	Mezcales	C. de Ortega	Col	18°45′	103°44′	25	*A*	RF	nc
58	San José	Manzanillo	Col	19°10′	104°10′	550	*A*	RF	nc
59	La rosa	Manzanillo	Col	19°10′	104°07′	500	*A*	RF	nc
60	Ostula	Aquila	Mich	18°30′	103°30′	210	*A*	2511	2511
61	Ostula	Aquila	Mich	18°30′	103°30′	230	*A*	2512	2512
62	Pomaro	Aquila	Mich	18°20′	103°20′	200	*A*	2514	2514
63	Pomaro	Aquila	Mich	18°20′	103°20′	210	*A*	2415	nc
64	Cachán	Aquila	Mich	18°15′	103°15′	15	*A*	2516	2516
65	Cachán	Aquila	Mich	18°15′	103°15′	15	*A*	2517	2517

Spanish term for an agave distillation site; all appear in place names in the study area. Ethnohistoric sources were used in this search, such as Lebrón de Quiñonez 1554 (Sauer 1948), the "Relaciones Geográficas de Michoacán y Nueva Galicia 1579–1580" (Acuña 1987, 1988), as well as period maps (Mirafuentes and Soberón 1974) and current maps of the region (INEGI 2000a, b, c).

Archaeological data

Visits were made to pre- and post-European contact sites along river banks, and in the lower and middle valleys of the river basins, in search of places where agave stems may have been cooked and/or ground, and the juices fermented and/or distilled. Identified sites were characterized in terms of: oven type; grinder type; fermenter type; still support structures; still type; water transport structures (to supply still); water storage structures; possible date of abandonment and proximity of coconut groves to site.

Ethnohistoric data

Reviews were made of Colonial era text (16th, 17th and 18th centuries) compiled by various authors: (1) The complete works of Francisco Hernández (1571–1577) (Somolinos 1960), (2) The descriptions of Colima in the 16th Century (Sauer 1948), (3) The testimonies in Colima Village city council acts (1612) (Sevilla del Río 1977), (4) The Documents for the History of Colima, 16th to 19th Centuries (Calderón 1979), and (5) The 16th- and 17th-Century historical collection of the Colima Village (Fuchigami 1990; Gómez-Amador 2000; Rendón-Garduño 2002; Romero de Solís 2004), (6) The 16th Century Geographical Relations of Michoacán (Acuña 1987), (7) The Michoacán Bishopric income report (1631) (López 1973), (8) The Michoacán Diocese tithe series 1636–1810 (Florescano and Espinosa 1987), (9) The 16th Century Geographical Relations of Nueva Galicia (Acuña 1988), and (10) The 17th Century Description of Nueva Galicia (de Arregui, 1619). Coconut spirits-producing haciendas

and agave distilleries reported in the ethnohistoric sources were located and visited.

Results

Botanical evidence

A total of 65 wild agave populations were recorded in the study area (Fig. 1). Herbarium and germplasm samples were taken in 55 of these populations, and ten photographic records were made of one because it was inaccessible and contained very young specimens (Table 1). *Agave angustifolia* Haw. was registered at elevations between 0 and 2,000 m, *A. rhodacantha* Trel. between 700 and 1500 m, *A. hookeri* Jacobi between 1,500 and 2,200 m and *A. colimana* Gentry between 0 and 700 m no cultivated agaves were observed in lowlands (0–700 m), save for a very few *A. tequilana* sown less than 5 years before in the Chamila and Tecomán valleys. Wild agave populations were very scarce in the lowlands and found only on very steep terrain free of human activity.

Toponymic data

Fourteen agave-related place names for human settlements were recorded in the study area, and most of these refer to an agave plant (e.g., *ixtle* or *mezcal*) or a place for distillation (e.g., *taberna*) (Fig. 1). Some towns have changed their name, such as Mezcales, Jalisco, which joined with Tecolotlán (Sauer 1948) and Mezcales, Colima, which changed its name to Cerro de Ortega in 1945.

Pre-contact archaeological data

A number of early human settlements have been described in the Tuxpan-Coahuayana and Ayuquila-Armería rivers area with different types of stone ovens that may have been used to cook agave plants, as well as stone and ceramic objects for defibering, grinding and fermenting agave (Schöndube 1994; Kelly 1949, 1980; Olay 2005) (Fig. 2: a–l). We observed stone ovens associated with human settlements at Los Mezcales on the Armería River, as well as at Las Guásimas, Los Ortices, and Chamila, the last a pre-contact cemetery site. In the Teuchitlán region, near the study area, organic offerings have been documented that indicate the predominance of agave fiber use for utilitarian purposes in late Formative Period (approx. 75 AD) tombs, and ceramic offerings in Classic Period (710–1100 AD) tombs in the Colima Valley that show the importance of agave for food, fiber, and beverages (Schöndube 2000; Vela 2006, p. 50).

Ethnohistoric evidence of agave plants use in pre-contact period

Ethnohistoric sources make clear mention of agaves and their use in production of a fermented agave drink throughout the Armería, Cuahuayana, and Coalcomán river basins at the time of European contact (Fig. 2):

> “There is in this province [Zapotitlan] a tree called MEXCATL (mezcal) that the Spanish call ‘maguey,’ from it are made wine, vinegar, honey, string, rope, wood for houses, needles, nails, thread, balsam for injuries ...”, “... And the wine the natives of this region [Maquili, Tlatictla, Oztutla, Motin, Pomaro, Qualcoman] use is of maguey (mezcal) and plum, of which there is an abundance ...of the magueys (mezcales) [a kind of aloe], the natives make use to obtain honey and thread, from which they make their clothing, and they make wine and vinegar”, “... the Indians [Colima] have made and make wine for their drinking sprees, from canes, maguey (mezcal), plums, maize, and other roots they have in their houses and on their lands, they make them in large quantities and cheaply.... the wines originating in this land are of maize, plum, mezquite, cactus pears, and maguey (mezcal)...” (Relaciones Geográficas del siglo XVI: Nueva Galicia 1580 in: Acuña 1988, p. 69; Relaciones Geográficas del siglo XVI: Michoacán 1580, in Acuña 1987, pp. 141, 158, 169; Osorio 1612, de Vera 1612 in: Sevilla del Río 1977, pp. 27, 60, respectively).

Ethnohistoric evidence about coconuts, the Philippine people and distillation

Coconut was first introduced to western Mexico at Colima in 1569 with raw material from the Solomon Islands, although an earlier introduction from Panama

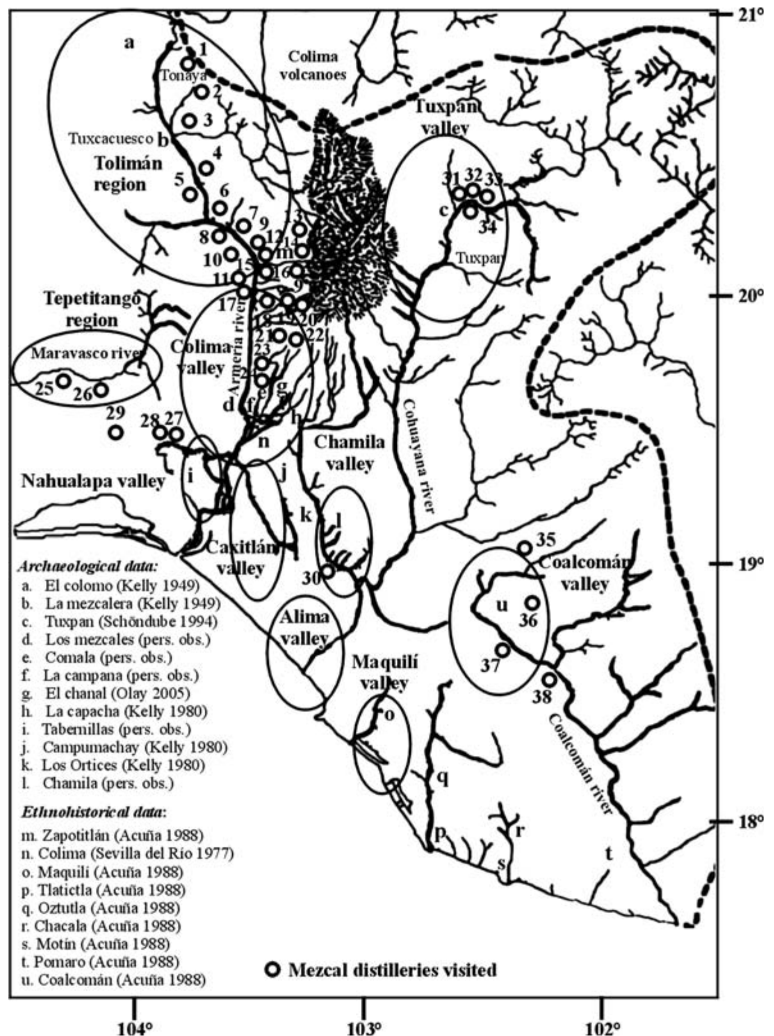


Fig. 2 Archaeological sites with reports of ovens assumed to be used for cooking agave plant (Archaeological data: a–l); sites referred to in historic sources where agave plant was used for fiber, food and drink at the time of European contact (Ethnohistorical data: m–u) (•); and agave spirits (mezcal) distilleries visited and described (○ 1–31, see Table 2)

in 1539 may also have occurred (Zizumbo-Villarreal 1996). It was also brought from the Philippines on a number of occasions between 1571 and 1821 (Bruman 1944b, 1945). Philippines were brought to Colima after 1571 and were primarily occupied in coconut cultivation and production of coconut spirits (*vino de cocos*) (Terríquez 1984; Fuchigami 1990). Several ethnohistorical sources indicate that *vino de cocos* is spirits:

> "... it is incorrect to call it vino de cocos because in reality it is spirits,... and to obtain it requires skill, a still and lots of work.", "... what the palms produce is spirits and must not be called a vino de cocos because it is not, because it is obtained with skill and work with a still, like in Castile..." "...vino de cocos is spirits that is produced with a still and is very healthy spirits..." (de Polonte 1612; García 1612; Muñoz 1612 in: Sevilla del Río 1977, pp. 36, 43, 64).

The first record of a producing coconut plantation dates from 1577 in Cajitlán (Romero de Solís 2004, p. 55). In the same year, Francisco Hernández mentioned that in New Spain:

> "...there are two main types of these palms, one good for fruit and another good for extracting spirits from ... from this tree wine, vinegar, honey, sugar, oil, milk, and butter are produced ..." (Hernández 1577 in: Somolinos 1960).

Other ethnohistoric sources suggest that the distillation technique could have been established between 1580 and 1600, when coconut plants began their reproductive stage:

> "... in this valley of Caxitlán the Indians and Chinese make coconut spirits (vino de cocos). The native Indians of these towns and the Indian servants get drunk ...",
> "... from twelve years to this time, ...that is the time that coconut spirits (vino de cocos) is made in large quantities, because when it was first made very little was made..." (Gómez-Amador 2000, p. 214; Toscano 1612 in: Sevilla del Río 1977, p. 73).

During the final decades of the 16th Century the area of coconut cultivation increased, and by 1600 a number of haciendas in Colima and the Caxitlán Valley were producing coconut spirits (Fuchigami 1990, p. 18; Gómez-Amador 2000, p. 163). In 1608, 14 haciendas were reported to have coconut wine production and in 1612 the drink was sold in 60 taverns in the Villa de Colima (de Velasco 1612 in: Sevilla del Río 1977, p. 163). By 1612 about 50 haciendas in Colima are reported to have been producing around 232,000 l of coconut spirits annually (Sevilla del Río 1977; Zizumbo-Villarreal 1996), and by 1631, 54 haciendas were producing about 262,000 l annually (López 1973; Zizumbo-Villarreal 1996) (Fig. 3). About 13 years later (1644) there were 110 registered producers among coconut plantation owners and renters, 153 vintners and 70 dealers and distributors (Fuchigami 1990, pp. 23, 24). The Michoacán Bishopric income reports for tithing concept, indicate that between 1630 and 1670 coconut spirits production was the main economic activity in Colima (López 1973; Florescano and Espinosa 1987). The rapid expansion of coconut cultivation and coconut spirits production led to incorporation of indigenous peoples into the production and distillation processes. Sources from the first decades of the 17th Century report that indigenous workers fell and died while harvesting sap from coconut palms (Fuchigami 1990, p. 20).

We visited 24 of the 54 haciendas reported in 1631 (Fig. 3), but found no remains of the distillation process. This is mainly because distillation infrastructure was not permanent and was placed in riverbeds to ensure sufficient water supply. Rivers in the area have changed drastically in the ensuing years due to storms, hurricanes and hydraulic engineering projects.

Ethnohistoric evidence of the coconut distillation process

Historic records indicate that coconut spirits production was done using the Philippine technique that produced a distilled drink called *lambanog* in that country:

> "... the shoot of the palm emerges to produce its fruit, they wrap it well with some ropes in many turns, and slowly cut it, once in the morning and again in the afternoon, and they have a calabash or cup hanging from it into which the water drips, which is called tuba, which when fresh is a sweet and flavorful drink; they then pour it into a vessel so it ferments a little and then they distill it in a still, what distills is the spirits, which is very strong, like the aguardiente of Castile ...", "... The stills are some hollow tree trunks the width of a man, covered with a copper casing full of water that, as it heats it changes, and in the middle of the hole is a round, adjusted table with a tube that comes out on one side which is where it distills ..." (Tello 1632 in: Sevilla del Río 1977, p. 129).

The coconut spirits industry dynamic was dictated by the high demand for spirits in the mining zones of Guanajuato, Pachuca, and Zacatecas, and the prohibitions against it emitted in response to the competition it generated with Spanish spirits (Sevilla del Río 1977). The first prohibition was emitted in 1603:

> " ... from this moment on no Spanish or Chinese person, whatever their status may be, shall be so bold as to take from the plantations and regions where coconut spirits is made, any in any amount to any of the Indian towns of the province [Colima], and, although it be with license and a store, from there to other regions or Spanish towns, under the punishment of losing said wine ... And it is prohibited and stated that no native Indian of this province

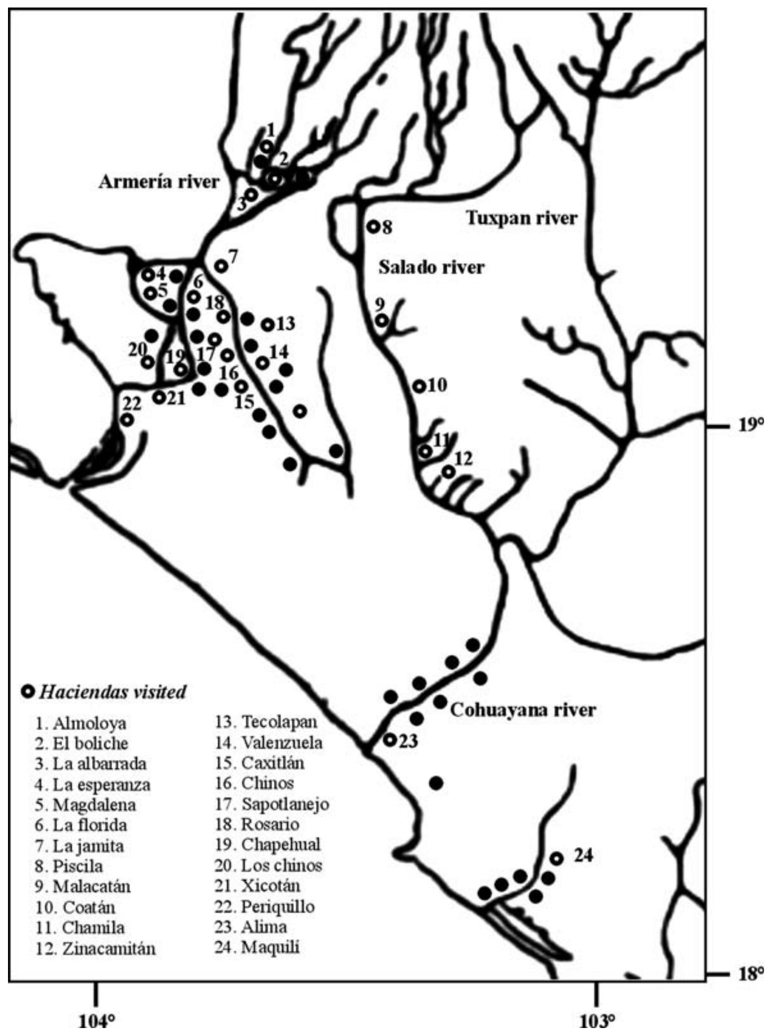


Fig. 3 Location of haciendas reported as coconut spirits producers in 1631 (López 1973). Visited (○) and not visited (●)

> shall make or can make from his trees or property any coconut spirits or tuba ...” (Escudero 1603 in: Sevilla del Río 1977, p. 13).

A new prohibition was dictated in 1610:

> “... By means of the present I prohibit all inhabitants of said provinces [Colima], whatever their status or condition may be, from making, profiting or selling publicly or secretly said coconut spirits for any reason, with the punishment of losing it and he who makes or sells it will pay one thousand Castilian ducats if he be Spanish ...” (de Velasco 1612 in: Sevilla del Río 1977, p. 164).

This same year the Royal Audience of New Spain prohibited the production and sale of coconut spirits and ordered the complete destruction of the coconut palm plantations in Colima due to the competition they generated for spirits imported from Castile (Sevilla del Río 1977). This order was not applied completely since some concessions were granted in 1627 and 1637 (Sevilla del Río 1977, pp. 170, 176).

Legal prohibition of coconut spirits production in the early 17th Century together with a growing demand for spirits in mining zones could have promoted production of agave spirits and its displacement up-stream. The first known description of agave spirits production is from 1619 and appears in the writings of Domingo Lázaro de Arregui, a Spanish cleric in Nayarit , subsequently compiled as a description of Nueva Galicia:

> "Mexcales are quite similar to maguey and their roots and leaf bases are eaten rosted, and from the same, squeezing them thus roasted, they extract a must from which they obtain vino by distillation, clearer than water and stronger than aguardiente and of the taste. And although many virtues are imparted from the mexcale, which is made, they (The Indians) use it generally with so much excess that they discredit the liquir as well as the plant... " (de Arregui 1619).

No evidence exists of agave spirits production in the highland valleys of Jalisco during the early 17th Century. As Walton (1977, p. 118) emphasized, while de Arregui makes no mention in 1619 of agave spirits production in his description of the correximiento of Tequila, it appears a few pages earlier the above description, related to the Indians toward the coast and the Sierra de Nayarit. Later on, in 1638, the Governor of Nueva Galicia decided to regulate the elaboration and commercialization of agave spirits (Muriá 2003), and by 1643 there are records of its commercialization in Guadalajara along with coconut spirits from Colima (Fuchigami 1990, p. 24; Gómez-Amador 2000, p. 224). By the early 18th Century, agave spirits may have been produced in the ravine bottoms of the Santiago River using wild agave populations (Luna-Zamora 1991, p. 40; Valenzuela-Zapata 1997, p. 25). By mid-century the first fields and stills had been established in the Amatitán, Tequila, Magdalena, and Arenal (Luna-Zamora 1991) valleys. By this time coconut spirits were no longer being produced in Colima due to the constant prohibitions from Colonial authorities (Calderón 1979, p. 161). Agave spirits production survived, however, in the foothills of the Colima volcanoes (Amula, Zapotitlán, and Tuxpan), in the ravines of the Colima Valley (Pérez 1776 in: Calderón 1979, p. 200), and in Ixtlahuacán, in the Chamila Valley, where it was considered an important product:

> "Mezcal plant is a genus of maguey, though not as large and with leaves not as thick as those in cooler lands, from this they take lots of mezcal spirits because it is abundant, and it is the best product of this land, it is valued for being wild." (Morales 1778 in: Calderón 1979, p. 223).

Post-contact archaeological evidence of agave distillation

We located and described 38 agave spirits distilleries (locally known as *tabernas* or *viñatas*), 20 of which were abandoned (Table 2, Figs. 2, 5–7). The 18 active agave distilleries used basically the same technique of cooking, juice extraction and fermentation, and have essentially the same structure. This includes the Philippine still with an earth, stone or wood base, two copper kettles, and a hollow tree trunk, usually made of *Enterolobium cyclocarpum* (Jaq.) Griseb. or avocado (*Persea americana* L.) (Fig. 4). At an archaeological site in the Chamila Valley, we identified a group of stone ovens of different sizes and shapes next to a series of underground wells, which had been reported as tombs (Fig. 5a, b). The smallest of these (from 1 to 1.5 m deep) may have been used as fermentation containers since an old dam, a basin and foundations that could have held stills are located nearby. In Comala we identified an abandoned *taberna* that had been operated clandestinely until the late 19th Century (Fig. 5c, d). In the Nahualapa Valley, next to the Aguazarca River, we located two old, abandoned distilleries, one called Tabernillas (Fig. 5e, f) and the other La zacatosa. In the Tepetitongo Valley, next to the San José River, we located another two old distilleries, one called La rosa (in use), and the other San José (abandoned) (Table 2).

In the foothills of the Colima volcanoes and Coalcomán area, we identified a number of functioning stills (Figs. 6, 7), that had incorporated significant "modern" modifications into the system: a gasoline-driven mechanical grinder to mash the cooked material, instead of the stone or wood grinder; plastic fermentation tanks instead of subterranean pits carved in the bedrock (locally named "rock pits"); submergible pumps to take water from streams; plastic pipe to divert river water; use of a serpentine Arab-type still instead of the Philippine still in a tree trunk; and plastic containers for spirits storage security and transport instead of clay or glass containers (Table 2). These modifications are all aimed at lowering costs by reducing labor requirements, increasing distillation process efficiency and ensuring more secure spirits storage.

Table 2 Location and descriptors of agave liquor distilleries (*tabernas* or *viñatas*) recorded in the study area

No.	Region	Site	Taberna name	River	Oven	Grinder	Drain	Basin	Fermentation container	Foundation	Still	Funtion	Coconut groves
1	Tuxcacuesco	Tonaya	Las parotas	Tonaya	Stone	Mechanic	Tube	No	Plastic	Cement	Steele	In use	Yes
2	Tuxcacuesco	Apulco	Apulco	Apulco	Stone	Mechanic	Tube	No	Plastic	Cement	Steele	In use	No
3	Tuxcacuesco	Tuxcacuesco	El pueblito	Tuxcacuesco	Stone	Mechanic	Tube	No	Plastic	Cement	Steele	In use	Yes
4	Tolimán	Tolimán	El abuelo	Tuxcacuesco	Stone	Mechanic	Tube	No	Plastic	Cement	Steele	In use	Yes
5	Tolimán	Tolimán	Los Gómez	Tuxcacuesco	Stone	Stone	Channel	Yes	Stone	Stone	Trunk	1960	Yes
6	Tolimán	Tolimán	De peña	Tuxcacuesco	Stone	Stone	Channel	Yes	Stone	Stone	Trunk	1960	Yes
7	Tolimán	Canoas	Las carretas	Armería	Stone	Stone	Channel	Yes	Stone	Stone	Trunk	1950	Yes
8	Tolimán	Canoas	Monte grande	Armería	Stone	Mechanic	Tube	No	Plastic	Stone	Steele	In use	Yes
9	Tolimán	Canoas	Tajipo	Armería	Stone	Stone	Tube	Yes	Piedra	Stone	Trunk	In use	Yes
10	Tolimán	Canoas	Las playitas	Armería	Stone	Stone	Channel	Yes	Piedra	Stone	Trunk	1960	Yes
11	Tolimán	Canoas	Porombón	Armería	Stone	Stone	Channel	Yes	Stone	Stone	Trunk	In use	Yes
12	Zapotitlán	Zapotitlán	El puente	Zapotlán	Stone	Stone	Channel	Yes	Stone	Stone	Trunk	1930	No
13	Zapotitlán	Zapotitlán	Parotillas	Zapotlán	Stone	Stone	Channel	Yes	Stone	Stone	Trunk	1940	No
14	Zapotitlán	Zapotitlán	Las tunas	Zapotlán	Stone	Stone	Channel	Yes	Stone	Stone	Trunk	1940	No
15	Zapotitlán	Zapotitlán	La humedad	Zapotlán	Stone	Mechanic	Tube	Yes	Plastic	Stone	Trunk	In use	No
16	Zapotitlán	Zapotitlán	Parota	Zapotlán	Stone	Mechanic	Tube	Yes	Plastic	Stone	Trunk	In use	No
17	Tolimán	Alceseca	Los pozos	Alsiseca	Stone	Stone	Channel	Yes	Stone	Stone	Trunk	1950	Yes
18	Tolimán	Alceseca	El paso	Alsiseca	Stone	Stone	Channel	Yes	Stone	Stone	Trunk	1950	Yes
19	Tolimán	Alceseca	Los chiNos	Alsiseca	Stone	Stone	Channel	Yes	Stone	Stone	Trunk	1930	Yes
20	Tolimán	Alceseca	El campanario	Alsiseca	Stone	Stone	Channel	Yes	Stone	Stone	Trunk	1930	Yes
21	Tolimán	San José	La concha	Los ganchos	Stone	Stone	Channel	Yes	Stone	Stone	Trunk	In use	Yes
22	Tolimán	San José	La cofradía	Los ganchos	Stone	Stone	Channel	Yes	Stone	Stone	Trunk	In use	Yes
23	Colima	Comala	Comala	Comala	Stone	?	Channel	Yes	Stone	Stone	Trunk	1950	Yes
24	Colima	Comala	Comala	Comala	Stone	Mechanic	Tube	No	Plastic	Cement	Steele	In use	Yes
25	Tepetitango	San José	San José	San José	Stone	?	?	?	?	?	Trunk	1980	Yes
26	Tepetitango	La rosa	La rosa	San José	Stone	Wood	Tube	No	Plastic	Stone	Copper	In use	Yes
27	Nahualapa	Tabernillas	Taberillas	Agua zarca	Stone	Stone	Tube	Yes	Stone	Stone	Trunk	1940	No
28	Nahualapa	Tabernillas	Taberillas	Agua zarca	Stone	Stone	Tube	Yes	Stone	Stone	Trunk	1940	No
29	Nahualapa	La sidra	La zacatosa	Agua zarca	Stone	Stone	Tube	Yes	Stone	Stone	Trunk	1950	No
30	Chamila	Chamila	Chamila	El salado	Stone	?	?	Yes	Stone	Stone	?	1778(?)	No
31	Tuxpan	Los arcos	Los arcos	Tuxpan	Stone	Stone	Channel	Yes	Stone	Stone	Trunk	1940	Yes
32	Tuxpan	Los arcos	Los arcos	Tuxpan	Stone	Stone	Channel	Yes	Stone	Stone	Trunk	1940	Yes

Table 2 continued

No.	Region	Site	Taberna name	River	Oven	Grinder	Drain	Basin	Fermentation container	Foundation	Still	Funtion	Coconut groves
33	Tuxpan	Los arcos	Los arcos	Tuxpan	Stone	Stone	Channel	Yes	Stone	Stone	Trunk	1940	Yes
34	Tuxpan	Arenal	Arenal	Tuxpan	Stone	Mechanic	Tube	No	Stone	Stone	Trunk	In use	Yes
35	Coalcomán	Torrecillas	Torrecillas	Coalcomán	Stone	Mechanic	Tube	No	Plastic	Cement	Wood	In use	No
36	Coalcoman	Las tabernas	Las tabenas	Coalcomán	Stone	Mechanic	Tube	No	Plastic	Stone	Wood	In use	No
36	Calcomán	Los parejos	Los parejos	Coalcomán	Stone	Mechanic	Tube	No	Plastic	Stone	Wood	In use	No
38	Coalcomán	Los telares	Los telares	Coalcomán	Stone	Mechanic	Tube	No	Plastic	Stone	Wood	In use	No

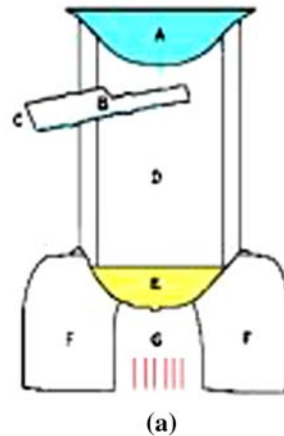
Discussion

The data suggest that agave spirits production began using *A. angustifolia*. This is the only species present in the lower basin of the Armería, Coahuayana, and Coalcomán rivers that has characteristics favorable for spirits production. Local rural communities still use it as food and to produce a fermented beverage, although this is limited by its scarcity. *A. colimana* is also found in this area, but does not have qualities favorable to spirits production and is not used as a food or to make a fermented beverage.

Introduced in 1569–1771, coconut production was used to make spirits early on (1580). This was before establishment of sugar cane cultivation in western Mexico and the production of commercial sugar between 1630 and 1650 (Florescano and Espinosa 1987; Zizumbo-Villarreal 1996, p. 511). The technology and knowledge for coconut spirits production was initially implemented by the Philippine people in Colima. However, between 1580 and 1600, the indigenous population was incorporated into the activity as the area under coconut cultivation expanded, coconut spirits production and sales increased, and this activity became economically important during the early decades of the 17th Century. Through their involvement in the spirits production process, indigenous workers learned the distillation technique and then applied it to the fermented beverages they already knew, such as that made from agave. This process was facilitated by the simplicity of the Philippine still, which could be built from locally available materials (Bruman 1944a).

The ethnohistoric and archaeological records indicate that coconut and agave spirits production could have developed simultaneously at sites near Ixtalhuacán, Comala, and Nahualapa. All the identified evidence suggests that agave distillation originated through adaptation of the coconut distillation process in Colima.

We identified no cultivated agave populations in the low river basins, and found no ethnohistoric records of its existence during the Colonial period. There are only reports of collection of agave plants from natural populations for use as raw material in production of agave spirits, as still occurs in a limited way. This suggests that agave cultivation, cultivar diversification and domestication did not begin in the



(a) (b)

Fig. 4 (**a**) Philippine still with internal receiver: A condenser (iron pan); B gutter (wood); C distillate outlet; D wooden cylinder; E boiler (iron pan); F furnace; G, furnace opening (Bruman 1944a). (**b**) Philippine type still in use in Canoas, Tolimán, Jalisco

lower river basins, even though agave spirits distillation could have begun there.

We found no wild agave populations at Ixtlahuacán and Mezcales (near Comala), even though archaeological and ethnohistoric records indicate agaves were important there during pre-contact and Colonial times, and the place names refer to the plant. The same occurred at Los Mezcales (near Colima) and Mezcales (near Cerro de Ortega), both communities named for this plant. The wild populations we did locate were isolated, included few individuals and grew on steep, inaccessible terrain far from human settlements. This suggests that wild populations have tended to disappear in the low river basins due to overexploitation and the absence of cultivated agave to shift pressure away from the natural populations. Agaves were probably not cultivated in the area in response to Colonial-era prohibitions on spirits production and close monitoring by authorities; cultivation of the raw material could have incriminated the producer.

Generalized use of subterranean pits carved in the bedrock ("rock pits") as clandestine fermentation basins, the presence of Philippine type stills, and the fact that the agave ferment use to distill is call "*tuba*" in the foothills of the Colima volcanoes suggest that the distillation process spread from the lower river basins to the foothill ravines. This was done to evade constant and severe prohibition of spirits production, and was favored by the presence of highland populations of wild *A. angustifolia*, as well as *A. rodacantha* in Jalisco and *A. hookeri* in Michoacán, both of which are apt for spirits production.

Increasing demand for spirits in mining zones in the 18th and 19th centuries, together with the disappearance of coconut spirits production and sale, promoted agave spirits production in inaccessible, isolated sites in the foothills of the Colima volcanoes, far from any vigilant authorities. These conditions also drove the spread of agave spirits production throughout western Mexico. Four factors were key to this diffusion process. First, the region is rich in *Agave* species with characteristics that make them apt for spirits production. Second, agaves had been used as food and to produce fermented beverages in the region since long before European contact (Bruman 1940). Third, the carving of wells in rock as graves, an aspect of ancient worship of the dead, was a traditional technique well-known among the indigenous population. This technique was readily adapted to excavating

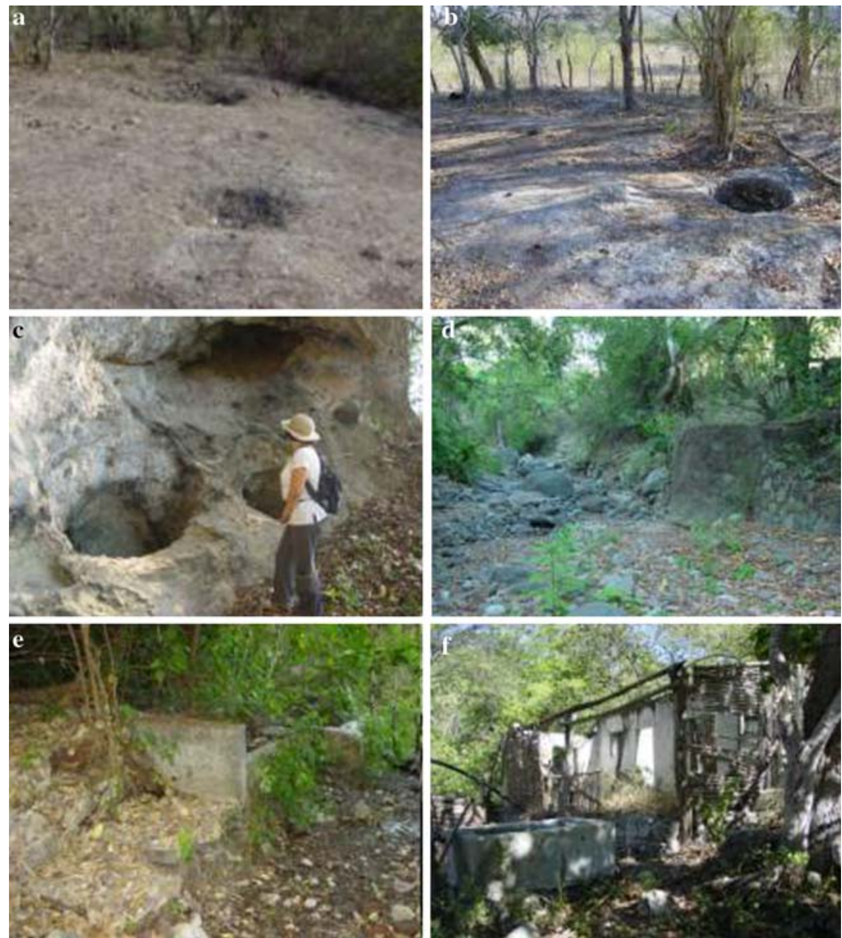


Fig. 5 Remains of agave spirits (mezcal) distilleries in the lower Armería and Coahuayana river basins. Chamila Valley: (**a**) underground stone ovens, (**b**) subterranean fermentation pit carved in the bedrock ("rock pit"). Colima Valley (Comala): (**c**) stone grinder (above) and "rock pit" (below); (**d**) dam and basin. Nahualapa Valley (Tabernillas): (**e**) basin, (**f**) main house

fermentation basins, and in fact many ancient graves were probably re-used for this purpose. And, fourth, trade routes existed from the area to the mining zones of Guanajuato and Zacatecas long before European contact. These followed the biological-cultural corridors of the Armería–Ayuquila–Tuxcacuesco, Tuxpan–Coahuayana and Río Grande–Magdalena–Tequila–Bolaños river systems. During pre-contact times these were used to transport salt, cacao, cotton, tobacco, and luxury items such as shells, conch, and ceramics (Sauer 1932; Standley 1996; Cabrero 2004) from the lowlands to the inland valleys; these were then used for salt and coconut spirits traffic and finally for moving agave spirits to the mining zones.

These trade routes would have served to disperse the Philippine still and distillation technique. Initially, these would have followed the Colima–Autlán–Ameca–Ahualulco–Etzatlán–Suchitepec (Magdalena) route, used by the Spanish beginning in 1524 for their northward explorations (Sauer 1932), and reached the Tequila, Amatitán and Arenal valleys, where the "mezcal" from Tequila first became popular in the 18th Century (Walton 1977). Along the route to the Bolaños and Zacatecas mines the Philippine still probably reached Bolaños, where it was reported by Lumholtz (1902) and Bruman (1944a). Following the Coahuayana–Tuxpan route towards the Guanajuato mines (Jiquilpan–Jacona–Lerma–Cuitzeo–Chupícuaro) the still would have arrived at the Tarasca Plateau, where it was reported by Bourke (1893), and at Queréndaro, where we observed it made from an *oyanel* (*Abies* sp.) trunk. Along the Cíbola route (Sauer 1932), this technology could have moved towards what is now the southeast United States of America and reached the mountains of Sonora, where a modified form was reported by Bahre and Bradbury (1980).

Clandestine agave spirits production was able to persist, despite Colonial-era prohibition, through the

Fig. 6 Agave spirits (mezcal) distilleries in the tolimán region: (**a**) A subterranean fermentation pit carved in the bedrock ("rock pit"), B tool use to take ferment out, C still from trunk; (**b**) underground stone oven; (**c**) "rock pit"; (**d**) Philippine type still; (**e**) "rock pit", sealed and covered with soil while the agave juice ("tuba") is fermenting; (**f**) opening of the "rock pit"

integration of two techniques: (1) adaptation of the ancient indigenous practice of carving subterranean pits in bedrock to create fermentation basins; and (2) adaptation of the Philippine distillation technique for coconut spirits production to agave spirits production. Carved into bedrock, the subterranean wells allowed production of ferments at relatively low and stable temperatures for relatively long periods (21–30 days). They were sealed with stones and earth, and thus considerably lowered the risk of discovery, and consequent destruction, by Colonial authorities, who could easily identify ferments in clay pots (Sebastián de Vera 1612 in: Sevilla del Río 1977, p. 60). Because the Philippine still is small, could be disassembled, easily transported and made of local materials (two copper kettles attached to a tree trunk), it could be installed, a batch of ferment distilled, then disassembled and moved very quickly. Only the tree trunk would be left behind, while the ferment remained buried for long periods, unseen.

Colunga-GarcíaMarín and Zizumbo-Villarreal (2006) stated that the Philippine still also had a significant effect on the selection and domestication of agaves for spirit production. The still's small size allowed production of spirits from a single agave individual, or very few individuals, meaning selection could be made of individual plants with the proper characteristics for spirits production. The vegetative propagation of agaves also permits cultivation of individuals with the characteristics of the selected progenitor, and conservation of these characteristics for many subsequent generations. Given these two conditions, recurrent selection and cultivation of agave individuals with characteristics favorable to spirits production could have generated a large number of morphologically distinct local cultivars,

Fig. 7 Agave spirits (mezcal) distilleries in the Tuxpan Valley and Coalcomán area: (**a**) underground stone oven; (**b**) subterranean fermentation pit carved in the bedrock (“rock pit”); (**c**) pots; (**d**) underground stone oven; (**e**) wooden fermenter; (**f**) modified Philippino type still

and led to domestication of agaves in the foothills of the Colima volcanoes (Vargas-Ponce et al. 2007).

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