

# A GUIDE TO MEZCAL AND TEQUILA

Blending the traditional aguamiel fermentation methods of Mexico's 70 indigenous/ethno-linguistic groups with post-colonial Mexican technology has resulted in the development of four Geographical Indication agave spirits: mezcal, tequila, bacanora and sotol. Though similar in many potential production approaches, where they vary is based upon the species of agave used and their specific region of Mexico.

image by Tequila Avión

## Hawaii BEVERAGE GUIDE

### HISTORY

*Historically all tequila was mezcal, but not all mezcal was tequila. This was similar to how all Cognac is brandy, but not all brandy is Cognac. However, laws have created Geographic Indications (GI) designations that define where and how mezcal, bacanora and sotol can be produced.*

#### **Pre-contact<sup>1</sup>**

Agave has been a significant plant to the indigenous people of Mesoamerica for millennia. It was primarily used for medicine and as a source of sugar for cooking, however all the parts of the plant were utilized. This included using the pencas to make roofing, needles, punches, pins and nails, and using the fibers for rope, paper and even as a type of container. The pencas could also be used as fuel and the resulting ashes used for soap, bleach or detergent. Given its significance, it was worshipped as the earthly representation of the goddess Mayahuel, who had 400 breasts to feed her 400 children, known as the Centzon Totchtin. Agave was also consumed in the form of pulque, made from fermented agave sap. Archaeological evidence suggests that it was distilled by repurposed bean steaming pots to create small quantities of a distilled beverage for ceremonial usage since the Capacha phase of the Early Formative period (1500–1000 BCE) in Colima.

#### **Post contact**

It was the introduction of stills and coconut palms by Filipinos on Spanish ships in the 1570s that led to the technology re-

quired to expand distillation.

It took a while for mezcal to become regularly consumed, however, since the colonial government prohibited the making of local products which competed with import of Spanish wines. It was not until the 17th century that tequila was legalized, as the government realized it could derive income from taxing what was already being made in secret.

Tequila's mezcal rose to prominence due to the greatest richness in agave species found in the region and its proximity to the San Blas, an important supply port in northwest Mexico during the 18th century. It was because of this proximity that the Tequila region's mezcal became the State of Jalisco's first export product.

#### **Tequila in the 1800s<sup>2</sup>**

With Mexican independence in 1821 and the decrease in imported Spanish liquors, Tequila's mezcal saw an increase in sales in Guadalajara, and a sales channel was established in Mexico City. Due to the rise in sales during this part of the early 19th century, some tequila producers also gained political influence. Further growth occurred during the middle part of the century as the port of San Blas was able to supply tequila to California, at the time still part of Mexico, with demand driven by the California Gold Rush of 1849. Further change to the tequila industry occurred during the middle of the century, as the Mexican Civil War of 1857 saw a distinguished tequila producer assume the governorship of the State of Jalisco fol-

lowing the defeat of the French, whom Napoleon III had sent in support of the conservatives. This social rift was even more apparent as Mexican high society retained a preference for French products, while the masses preferred mezcal and tequila. It was the masses that continued to propel tequila's growth.

#### **Tequila in the 1900s to 1950s<sup>2</sup>**

The beginning of the 20th century was the period which changed tequila from a beverage into a national symbol. The century started with the overthrow of the dictator General Porfirio Diaz in 1911, and the beginning of tequila's association with Mexican national identity. According to El Consejo Regulador del Tequila "Drinking tequila instead of imported distilled liquors was one of these gestures. What's more, even the government consciously favored the image of tequila, almost as a national symbol." There were also major changes from 1917 to 1940, as the large hacienda owners like Cuervo, Sauza and Herradura went from growing their own agave to outsourcing the farming due to the creation of communal agricultural lands. Popular music of the time, as well as the Mexican film industry, which "contributed beyond measure to tequila's popularity by creating a misleading stereotype of what it meant to be Mexican," further strengthened tequila's image. There was also a viral campaign in which tequila became associated with fighting the Spanish Flu of the 1930s. The development of a bottling industry in Monterrey helped

to meet the demand. This era also saw an oil boom on the Gulf Coast of Mexico. Tequila's bottling enabled the oilmen to easily transport a 500mL bottle in the "back pocket of loose-fitting trousers" which was the style commonly seen on cinema screens.

The next big change in tequila was in the 1950s, as major technological advancements in its production allowed for increased yield without detriment to quality. However, during this period, the import of cheap cane spirits to Mexico destroyed the market for locally made spirits.

#### **Tequila in the 1950s to current**

The next major change occurred when, in 1974, tequila became a product protected by Geographical Indication under Mexican law. It took until the 1990s for the industry to flourish, however. This decade saw the formation of the Consejo Regulador del Tequila (CRT) in 1993 to oversee compliance with the laws, as well as the recognition of tequila and mezcal by the North American Free Trade Agreement in 1994 and in 1997 by the European Union. One of the significant outcomes of the aforementioned trade agreements was the significant shifting in the production of agave distillates exclusively to Mexico. Previously, "tequila" was produced in several countries including Spain and South Africa.

The 2000's have been marked by a series of boom and bust cycles for producers. This is caused by spikes in agave prices, due to unexpected increases in demand but a supply limited by a product that takes seven years to grow. This results in producers, in particular the smaller ones, unable to purchase enough agave to keep their operation in business.

#### **Mezcal and other Agave Spirits**

When tequila became a large commercial industry, mezcal remained hyper-local and was only produced at an industrial scale by a few companies. There was also classism associated with the product until recently, since it was seen as a drink of the pueblos, which the wealthier classes associated with poverty. In the 1990s, most commercial mezcal was 95% aguardiente and 5% mezcal. In the rural countryside, it remained in its traditional form, produced at non-regulated distilleries without the usage of running water or electricity in any part of the process, and sold only when excess product was available. It was not until 1994 that the mezcal GI was established.

The GI for bacanora (NOM 168) were established in 2000, and the GI for sotol (NOM 159) in 2002. Much of this rise in popularity for agave spirits was driven by U.S. demand.



#### **Alcohol and Tobacco Tax and Trade Bureau (TTB) Tequila Laws**

The laws governing tequila, are those "in compliance with the laws and regulations of the Mexican Government...", however the TTB does require (the Mexican government does not) that tequila shall be bottled at not less than 40% alcohol by volume (80 proof).

#### **\*Norma Oficial Mexicana (NOM) translates to "Official Mexican Standard"**

##### **Mexico's Governing Laws for Tequila:**

###### **NOM-006**

[crt.org.mx/images/documentos/Normas/NOM\\_006\\_SCFI\\_2012\\_Ingles.pdf](http://crt.org.mx/images/documentos/Normas/NOM_006_SCFI_2012_Ingles.pdf)

##### **Official definition of Tequila (Section 4.36)**

"The regional alcoholic beverage obtained by distilling musts, prepared directly and originally from extracted material, in the manufacturing facilities of an Authorized Producer, which must be located in the territory specified in the Declaration, derived from the hearts of tequilana weber blue variety agave, previously or subsequently hydrolyzed or cooked, and subjected to alcoholic fermentation with cultivated or uncultivated yeasts, wherein said musts may be enhanced and blended together before fermentation with other sugars up to a proportion no greater than 49% of total reducing sugars expressed in units of mass, pursuant to this Official Mexican Standard, and with the understanding that cold mixing is not permitted. Tequila is a liquid that may have color, when matured, mellowed, or added with a specific color."

##### **NOM, the Registered Distillery Number on Every Bottle:**

"Each tequila distillery has a unique NOM, and each bottle of tequila shall bear this NOM." However, the NOM may be misleading, as many contract distilleries have equipment and facilities for a multitude of production processes, for example both autoclaves and brick ovens. This

makes understanding a particular brand's production processes critical. Similarly, there is a broad spectrum of approaches to contract distilling. The easy way is to bottle pre-made, generic products. There is also the customized way, which equates to renting the facility and having the distillery supply agave, then making the distillate yourself with physical labor provided by the distillery staff.

The NOM of each brand can be found at: [crt.org.mx/images/Documentos/Marcas%20Certificadas%20de%20Tequila%2012%2001%2021.xlsx](http://crt.org.mx/images/Documentos/Marcas%20Certificadas%20de%20Tequila%2012%2001%2021.xlsx)

##### **Tequila Classifications (Section 5.1)**

###### **"100% agave" (Section 5.1.1)**

"Pursuant to Section 4.34 of this NOM, a product whose fermentation may not be enhanced with sugars other than those obtained from the tequilana weber blue variety Agave grown in the territory specified in the Declaration. For the product to be considered "100% agave" tequila, it must be bottled in the bottling plant controlled by the Authorized Producer, which must be located within the territory specified in the Declaration. This product must be labeled using one of the following statements: "100% de agave," "100% puro de agave," "100% agave," or "100% puro agave," to which the word "azul" (blue) may be added."

###### **"Tequila" also known as Mixto**

###### **(Section 6.3: Addition of other sugars)**

"The product covered under this NOM may be enhanced with other sugars in the fermentation process up to a proportion not to exceed 49% of total reducing sugars . . . This maximum enhancement of up to 49% of total reducing sugars expressed in units of mass may not be done with sugars from any species of Agave. The 51% of total reducing sugars expressed in units of mass may only be enhanced with tequilana weber blue variety agave grown in the territory specified in the Declaration."

# MEZCAL LAWS

## Alcohol and Tobacco Tax and Trade Bureau (TTB) Mezcal Laws:

Spirits distilled in Mexico in compliance with the laws and regulations of the Mexican Government from a fermented mash derived from the mezcal plant, having the taste, aroma and characteristics generally attributed to mescal/mezcal and bottled at not less than 40% alcohol by volume (80 proof).

## Mexico's governing laws for Mezcal

### NOM-070

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## Mezcal Styles (Section 4.4.1 to 4.4.3 of NOM-070-SCFI-2016)

**Production Regions:** Mezcal must be made in the regions of Oaxaca, Guerrero, Guanajuato, San Luis Potosí, Zacatecas, Durango, Tamaulipas, and recently added Michoacán and Puebla. Of these production regions, Oaxaca is by far the largest production region, with Durango a distant second.

### Mezcal Blending

Blending is only allowed if the mixture of mezcal is the same category and class from the same palenque.

Mezcal's preparation must comply with at least the following four stages and equipment:

	Mezcal	Artisan Mezcal	Ancestral Mezcal
Cooking	Cooking of agave piñas or juices of agave in underground pits, above-ground masonry ovens or autoclaves.	Cooking of agave piñas in underground pits or above-ground masonry ovens.	Cooking of agave piñas must occur in underground ovens.
Milling	Tahona/Molino (Chilean/Egyptian mill), cane press, chipper, roller mill or diffuser.	Wooden Mallets, Tahona (Chilean or Egyptian mills), Cane Press (trapiche) or chipper	Wooden mallet, tahona/molino, (Chilean/ Egyptian mill)
Fermentation	Containers of wood, concrete or stainless steel.	Rock pits, in-ground pits, containers of masonry, wood or clay, or animal skins. The process may include the fiber of the maguey (bagasse).	Rock pits, in-ground pits, tree trunks, masonry tanks, containers of wood or clay, or animal skins. The process may include the fiber of the maguey or agave (bagasse).
Distillation	Alembic stills, continuous or column stills made of copper or stainless steel.	A still made of copper or clay with a head made of clay, wood, copper, or stainless steel which must be directly heated by a fire. The process can include the fiber of the maguey or agave (bagasse).	Distillation must occur in a still made of clay with a still head made of clay or wood. The process may include the fiber of the maguey or agave (bagasse).

## 4.5. Classes of Mezcal

### Abocado con

Mezcal on which ingredients are directly incorporated to add flavor. Examples include worm of maguey, damiana, lemon, honey, orange, mango, among others, provided that they are authorized by the Agreement corresponding to the Ministry of Health (see 2.10), and as in the NOM-142-SSA1 / SCFI-2014 (see 2.2).

### Destilado con "Distilled with"

Mezcal that must be distilled with ingredients to incorporate flavors, such as breast of turkey or chicken, rabbit, mole, plums, among others, in terms of the present Standard Official Mexican.

### Mezcal Style Note

When mezcal was outlawed and pushed out to the rural areas, it preserved traditional methodologies of distilling, as many of these villages had no electricity or running water. Even when mezcal was legalized, the financial barrier to entry due to permitting and logistical costs prevented many producers from entering the domestic (Mexico) market. It was not until the recent mezcal boom which has brought in international companies who partner with these producers and assist with the legal and logistical hurdles, that "modernization" has even become a discussion. To preserve these rustic styles, Section 4.4.1 to 4.4.3 were added to the already existing NOM-70 in 2016.

# TYPES OF AGAVE

Agave, as classified by German botanist F. Weber in 1905, is a succulent in the lily (amaryllis) family; it is not a cactus. The piña is rich in carbohydrates, including inulin, an oligosaccharide of fructose. In the agave family, there are different varieties that can be used to produce mezcal.

It should be noted that only Agave Azul and Espadín are well researched as they are the major cultivated varieties (Espadín makes up 80%-90% of all commercial mezcal production). Similar to the confusion between various grape varieties in the wine industry before extensive genetic testing, there are nomenclature confusions as a particular species may be called something different depending on in which village it is grown. Additionally, identifying the multitude of phenotypical variations without genetic testing has also led to nomenclature discrepancies.

More importantly, variations in temperature, sunlight, water, and soil are key factors in the growth and development of agave and have significant impacts on the final flavor in the same way that Cabernet Sauvignon grown in Bordeaux is different than Cabernet Sauvignon grown in Paso Robles. The decisions as to when to pick the agave is also similar to that of when to pick grapes. That is phenolic balance and sugar ripeness are both essential to create a great distillate. The exact brix at harvest will vary by producer and region.



SPECIES: AGAVE TEQUILANA

- Common name: Agave azul/ Blue Weber Agave

**Agave for Tequila must be grown in** the state of Jalisco and some municipalities of Nayarit, Tamaulipas, Michoacán, and Guanajuato. The Jalisco growing regions in Jalisco are:

**Amatitán-Tequila Valley “Lowlands”**

Elevation: 4,000 ft  
 Average annual temperature is 69.5 °F (Amatitán)  
 The annual rainfall: 25.2 inches (Amatitán)  
 Soils: Rich in organic material, black valley soil

**Los Altos “Highlands”**

Elevation: 6,500 ft  
 Average annual temperature is 63.1 °F (Arandas)  
 Annual Rainfall: 43.1 inches (Arandas)  
 Soils: Sandy, iron-rich soil.

**Agave for Mezcal must be grown in** a designated mezcal region.



SPECIES: AGAVE ANGUSTIFOLIA

- Common name: Espadín
- Found in Oaxaca
- Harvest: 6-11 years
- Harvest Brix: 30-43 ° Bx
- Some producers harvest lower Bx.

Images by Del Maquey



SPECIES: AGAVE POTATORUM

- Common name: Tobalá
- Found in southern Mexico across Oaxaca, Puebla
- Harvest age: 10 - 15 years
- Harvest Brix: 20-25 ° Bx.
- \*Tobalá is a rare because it does not reproduce asexually.



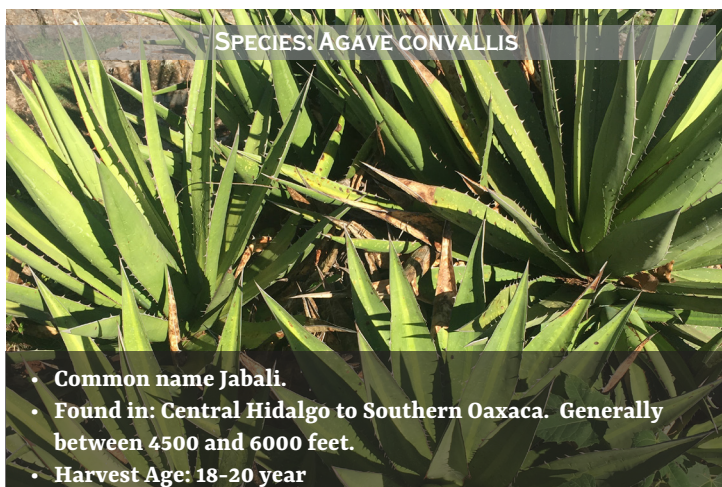
SPECIES: AGAVE KARWINSKII

- Common names: Madrecuixe, Cuishe, Bicuíshe, Barril, Tobaziche, Verde
- Found in Oaxaca and Puebla
- Harvest Age: 10+ years to mature
- Harvest Brix: 18-24 ° Bx. Many dry dusty flavored Karwinskii mezcals are harvested at lower Bx.



SPECIES: AGAVE MARMORATA

- Common names: Tepeztate, Pizorra
- Found in: Southern Mexico, particularly in Guerrero and Oaxaca
- Harvest age: Up to 30 years old
- Harvest Brix: 18-22 ° Bx.



Images by Del Maquay

**Species: Agave durangensis**

- Common Name: Cenizo
- Found in: Oaxaca, Jalisco, Puebla, and Michoacán. The most common agave used in Durango.
- Grows in: Cold, dry, high altitude regions of up to 8,500 ft.

**Additional insight into the geographical distribution of agave:**

García Mendoza, Abisaí. (2002). Distribution of Agave (Agavaceae) in Mexico. 74. 177-187. [https://www.researchgate.net/publication/303263665\\_Distribution\\_of\\_Agave\\_Agavaceae\\_in\\_Mexico](https://www.researchgate.net/publication/303263665_Distribution_of_Agave_Agavaceae_in_Mexico)

## OTHER INGREDIENTS

**Water**

Producers have traditionally sourced water from natural springs or wells on property, while others, in particular tequila producers, will truck in water. Currently, many high volume tequila producers use reverse osmosis water. Water’s impact on the production of agave spirits is a difference in flavor, derived in part by its influence on the development of yeast and other fermentation microbes.

**Yeast**

Agave is traditionally fermented by a combination of yeast and bacteria. Depending on the producer, wild inoculants may also play an active role in fermentation. This is especially common in the production of mezcal.

- **Tequila<sup>5</sup>:** In the fermentation process, *Torulaspora delbrueckii*, *Kluyveromyces marxianus*, and *Hanseniaspora* spp. progressively ceded the way to *S. cerevisiae*, *Zygosaccharomyces bailii*, *Candida milleri*, and *Brettanomyces* spp. Lactic acid and acetic acid bacteria are also common.

- **Mezcal<sup>6</sup>:** In the mezcal fermentation process, the typical yeasts found are *Pichia kudriavzevii*, *Pichia manshurica*, *Saccharomyces cerevisiae*, *Kluyveromyces marxianus*. Somewhat uniquely, *Saccharomyces cerevisiae* is not always present as an inoculant. If *S. cerevisiae* is absent, mezcals may lack the fruity notes produced by the esters in the same way that an ale beer has fruity notes, as opposed to a lager beer. A study suggested that *Kluyveromyces marxianus* could be a suitable starter in artisanal mezcal production if the mezcal were to be inoculated.

## CULTIVATION

All of the aforementioned species of agave can be cultivated, however the two primary cultivated species are *Agave tequilana* (agave azul) and *Agave angustifolia* (espadín).

Cultivated agave is planted in typically non-irrigated fields called potreros, campos de agave, huertas, or groves. In the process of growing and harvesting tequila, the only potentially mechanized parts of cultivation are the use of trucks for hauling as well as weeding and pesticide spraying.

### Propagation

Agave reproduces both sexually and asexually.

- The sexual reproduction of agave requires bats to pollinate the female agave's quicote (flower stock) to produce seeds. This is the typical reproductive method of wild agave, but is not used in commercial cultivation of agave azul. It is more common for espadín cultivation. Male agave do not sprout a quicote, and in its place have a dense circle of leaves called cogollo.
- Agave reproduce asexually by producing shoots called hijuelos. These shoots develop when the plants reach approximately four years of age. In commercial production, especially in tequila production, hijuelos are cut from the mother plant and replanted. This differs from some espadín producers, which allow plants to reproduce both sexually and asexually.

### Growing and Pruning

Agaves are regularly pruned to encourage piña growth. In particular, the quicote or flowerstalk of the plant may be cut to discourage energy being diverted towards reproduction. This is a controversial practice as it leads to low genetic diversity and makes the agave population more susceptible to disease. Weeding of the fields is done both mechanically and by the use of herbicides and pesticides. However, the usage of pesticides and herbicides stops the year before harvest to minimize residue.

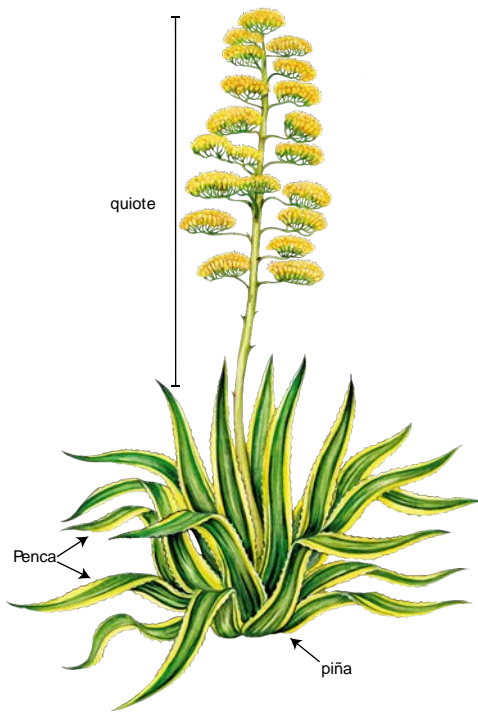
### Harvest

*Tequila* regulations, as of March 2006, require agave to be picked at a minimum of 24 brix. Typically, at this sugar ripeness, the agave is 8-10 years old and the piña weighs 80-200 lbs. Producers may choose to pick agave at higher brix or with additional criteria. Due to this sugar-ripening approach, agave can be picked year-round. From a functional approach, harvest occurs during the non-rainy/muddy season because it is easier to drive the trucks which carry the agave through the fields

*Mezcal* does not have regulations on when agave may be harvested because each varietal has different brix when mature. However, producers are legally required to keep track of the brix at harvest. In the traditional Zapotec way of farming, as the field develops and agave ripen at different rates, only the ripest agave will be picked to make a batch. The farmer then comes back around to harvest agave for the next batch of once it ripens.

To harvest the agave, jimadors (palenqueros in Oaxaca) cut the penca off in the field using a pole with a cutting edge called a coa (in Oaxaca a machete or ax is more common). Removing the penca in the field makes it easier to transport the piñas. However, how much of the penca is removed varies by producer as the amount of penca remaining will affect the overall methanol content and will add some bitterness. In the traditional method for both mezcal and tequila, a few inches of the penca are left on the piña. In a more "modern" method, additional penca will be removed to the point where the agave is completely white. Though eliminating the threat of methanol by removing a higher percentage of the penca creates higher yields, it sacrifices a richer flavor profile. It should be noted that using mature agave with high sugar content can offset the bitterness from the penca. Additionally, on male agave, some producers will take an additional step of removing the cogollo because it can impart a very bitter flavor to the distillate.

The quantity of agave required to make a spirit is highly dependent on brix at harvest, as well as the still type. In Tequila 7 kilograms of agave will produce approximately one liter of spirit whereas Del Maguey has found that clay pot stills require 16-18 kilograms of Espadín per liter, versus 9-10 kilograms per liter in a copper pot still.



Images by Rudy Prather/unsplash

# COOKING/HYDROLYSIS

To hydrolyze the fructan content and break down the complex polysaccharide chains of sugars into fermentable sugars, the agave must be “cooked”. This occurs in the following ways:

## Earthen Pit

*Typically used in: Artisan mezcal (rarely used in tequila production)*

The traditional way to cook agave is generally similar to building a Hawaiian imu, except using bagasse instead of burlap sacks. Each family has its own specific traditions on how to roast and how long it stays in the ground, which can have significant influence over the final flavor as well as the level of smokiness in the final distillate. The general process of roasting agave in an earthen pit involves:

1. Digging a hole in the ground. The more advanced version is a reusable hole lined with stones.
2. Building a fire from hardwoods of pine, oak or mesquite (which burn slowly).
3. Covering the wood with river rocks (or rocks that don't explode when heated).
4. Lighting the wood on fire.
5. When the rocks are red hot, and much of the fire has died down, the rocks are covered with spent agave fiber (bagasse) from a prior distillation to provide insulation so that the agave does not touch the rocks and burn. The quantity of smoke present when the agave is put into the oven varies by producer.
6. Lining the pit with agave. In this phase, when making mezcal that is not tequila, one or more type of agave may be used.
7. The final set of insulating layers are put onto the roast. This typically includes another layer of bagasse, then palm thatched mats, then nylon tarps to contain the smoke, then a final layer of dirt to lock in all the heat and smoke.
8. Often the roast is blessed, because of the high investment into agave and the workers used to pick it.
9. At the midpoint of the roast, it is checked for adequate temperature. This can be done by pouring water into the roast and looking for the proper steam reaction.
10. The roast is typically 3-5 days long with some producers with some types of agave roasting for up to 30 days.
11. The agave are allowed to rest. While resting, a green sheen caused by a particular bacteria will form on the skin of the agave. This is an indicator that the agave has cooked adequately, as the bacteria growth indicates that the sugars are broken down. The resting phase varies by agave and producer. In general, however, it is rested for up to a month.

## Hornos (Brick Oven)

*Typically found in: Craft tequila production; may also be used in artisan mezcal and mezcal*

Hornos use steam to cook agave at 140 to 185 degrees Fahrenheit for 36 to 72 hours. This produces non-smoky tequila, and is faster and easier to unload than using an earthen pit.

## Autoclaves

*Typically found in: High volume tequila production and non-artisan mezcal*

Autoclaves are stainless steel pressurized ovens which cook the agave at a higher heat than in the Hornos. This takes 7-12 hours.

## Diffuser Only

*Typically found in: Budget tequila production*

Agave is first shredded, then put into a diffuser which uses high-pressure water jets to break apart the agave and dissolve the sugars. To hydrolyze the agave, there are two options:

- Use acid to break down the fructans into fermentable sugars. Hydrolysis by acid alone is not typical, because it leaves many non-fermentable sugars. The acid-only technique is not permissible in the production of mezcal.
- Use an autoclave to cook the agave using heat. Acid can be used in conjunction with the autoclave to speed up the conversion time. This is the most common method for producing high-volume tequilas.



## EXTRACTION/ CRUSHING

After the agave is cooked, the juice, called mosto, is separated from the fibers through a crushing process. This can happen in the following ways:

### **Hand-Crushed**

The traditional way to crush agave was by hammering it in a hollowed out tree trunk with wooden mallets/bats called canoas y masos before adding it to the fermentation tank. In this process, the agave fibers are not broken.

### **Molino/Tahona (Stone Wheel)**

A volcanic stone wheel, or a wheel made from cement and wire weighing up to three tons is pulled in a circle and mashes the agave into a fibrous pulp with minimal breakage of fibers. The pulling of the tahona was traditionally done by mules, horses, or oxen. It is now typically done using a motor to drive the tahona, although some mezcal producers still use a horse. The usage of the horse may add to the microbiome of the fermentation. This will generally mill one ton per day. Once milled, all of the fiber and liquid will be placed into the fermentation vat.

### **Screw Mill**

A screw mill is a compromise between the tahona and roller mill, because some fibers are broken in the process, but not as many as the roller mill.

### **Roller Mill**

Roller mills are currently the most utilized method for crushing agave. During this process, producers are careful to minimize the amount of fibers put into the fermentation tank.

### **Diffuser after cooking in a brick oven or autoclave**

Diffusers can also be used to extract the sugars from agave after it has been cooked.

### **A combination of any of the previous techniques**

Some producers will use a combination of the aforementioned techniques. This can be done to increase economic efficiencies. For example, after a roller mill is used to shred the agave, a diffuser may be used to extract residual sugars from the agave fibers.

## FERMENTATION

### **Time**

Yeast strain, temperature and carbon-to-nitrogen ratio (agave is low in nitrogen) are the biggest factors in the speed of the fermentation. To speed up the process, nitrogen may be added using tepehuaje oak bark, (the traditional way to add nitrogen) or by adding ammonium sulfate in the industrial method. It should be noted that a longer fermentation may result in a more robust final distillate. There are limits, however, as acetic bacteria will oxidize ethanol as well as produce vinegar flavors which in rare cases can be tasted post distillation.

- Mezcal: Typically 5-10 days. If temperatures are low, the process can take up to 30 days.
- Tequila: 3-8 days

### **Container :**

- Tequila: Both closed top and open top containers made from wood or stainless steel are common
- Mezcal: See *Mezcal Laws* on page 4.

### **Temperature:**

- Mezcal: Ambient temperature.
- Tequila: 86-99 degrees Fahrenheit, but highly dependent on the distillery and whether temperature control is used.

### **Inoculation Style (for inoculants, see yeast on pg. 6)**

- Mezcal: Spontaneous fermentation is typical. Inoculation is also permissible.
- Tequila: Typically inoculated. Spontaneous fermentation is permissible.

### **Process**

Mezcal: Agave, including the fibers, are loaded into the fermentation tank, called a tina. The agave is left to ferment on its own for approximately three days in open-top fermenters. Water is then added. Fermentation is highly variable and is based upon agave brix and ambient temperature. This can take between 8-30 days..

Formulation with water usually takes place 24 hours after milling. Many producers rest their piñas after uncovering the roast, so fermentation has already begun on the whole piña during this process. Once milled, all the internal sugars are exposed and left for a 24-hour "dry" fermentation before water is added.

Sometimes pulque is added to the ferment to jump start the process during colder months.

Tequila: the fermentable sugars are combined with water in the fermentation vessel, and then inoculated. With "Mixto" Tequila, as much as 49% of the fermentable sugars may be derived from non agave azul sources, including cane sugar, corn syrup, glucose, or molasses.

### **Completed Fermentation**

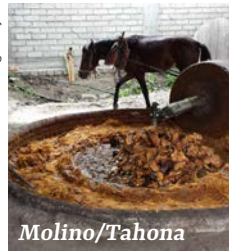
Final ABV is highly dependent on the producer

- Mezcal: 3.4-8% ABV
- Tequila: 4-12% ABV

### CRUSHING



Hand-Crushed



Molino/Tahona



Molino/Tahona

### FERMENTATION



Images by Del Maguey

Images by Del Maguey

Images by Tequila Cazadores

### **Volatile Compounds in Tequila vs Mezcal<sup>2</sup>**

Describing the differences between the aroma profiles of agave spirits can be difficult, because many are very similar. One way to look at how they vary is through their chemical compositions:

- Tequila categories showed differences in the methanol, 2-/3-methyl-1-butanol (apple or banana flavor), and 2-phenylethanol (floral) concentrations, with lower concentrations in the mixto category.
- Espadín Mezcal: 3-ethylphenol (must) was identified only in samples of mezcal made from *A. angustifolia*.
- Tobala Mezcal has high ethyl acetate (fruity) and 2-Methyl-1-propanol levels.



Cazadores Distillery  
pot stills



Clay Stills at  
Minero Palenque



Copper Mezcal still at  
Chichicapa Palenque



Pot still used to make  
Tequila Komos

## DISTILLATION

**Tequila** is typically double distilled, but can be triple distilled. In the stripping run, the ABV is raised to approximately 25% and in the final distillation traditionally ranged from 55-60% ABV.

**Mezcal** is double distilled. The stripping run separates the from the bagasse and results in "Ordinario". The Ordinario is then redistilled, and the following cuts are made (the ABV of each cut varies by producer):

- Puntas "Heads": 55% to 85% ABV
- El corazon "heart": 45% ABV to 55% ABV
- Colas "Tail": 45% ABV and lower.

### **Other Distillation Notes**

- The ABV was traditionally found by "reading" the size and quantity of the pearls, or bubbles in the mezcal.
- Traditionally the final ABV has varied by producer.

### **Still type**

The still has significant influence on the resulting distillate. Typically clay stills have the most body, column stills having the least body and pot stills falling in between.

### **Filipino (clay pot still)**

Clay is porous and results in lower yields of distillate than a copper still due to lots of loss. However not all clay stills are the same. For more insight into this fascinating category of distillation as it pertains to agave spirits read:: Valenzuela-Zapata, Ana Guadalupe. (2014). East Asian Stills. Distillation influences in Mezcal (agave spirits) production in Mexico.

[www.researchgate.net/publication/333194635\\_East\\_Asian\\_Stills\\_Distillation\\_influences\\_in\\_Mezcal\\_agave\\_spirits\\_production\\_in\\_Mexico](http://www.researchgate.net/publication/333194635_East_Asian_Stills_Distillation_influences_in_Mezcal_agave_spirits_production_in_Mexico)

### **Pot Still/Alembic still**

There are a multitude of pot stills. They can be made out of copper or stainless steel. They can also be heated using a wood burning fire or electricity. In the agave spirits industry it is common to see producers use smaller stills than in the whiskey industry, but instead implement more of them.

### **Pot Still and Column Still**

As tequila must be double distilled, using a column still along with a pot still is the typical set-up if a column still is used. This is similar to many whiskey still setups.

### **Special Distillation Techniques**

#### **Mezcal Destilado con "Distilled with"** (NOM-070- Section 4.5 (f))

Mezcal can undergo a third distillation in which an additional ingredient is included for flavor. These additional ingredients include breast of turkey or chicken, rabbit, mole, or plums, among others. A popular style of Mezcal Destilado con is Pechuga, which is Spanish for "breast". This refers to the usage of a chicken or turkey breast hanging within the still. The style can be traced back to 1863, in an article written by D. Manuel Payno called "Memoria Sobre El Maguey Mexicano Y Sus Diversos Productos".<sup>8</sup>

# RESTING / AGING

## **Aging Tequila (NOM-006 Section 4.3)**

### ***Barrel Type***

requires the barrels to be of oak or Encino oak (holm or holm oak) with a maximum capacity of 600 liters. Typically, the spirit is aged in previously used casks. Using a NOM, look for companies which own both bourbon and tequila distilleries, as it is common to find the bourbon barrels used in the tequila aging process.

- French oak provides baking spice notes.
- American oak provides notes of vanilla and caramel.

### ***Blanco (Silver Tequila)***

“Transparent product not necessary colorless, *without additives*, obtained through distillation, whose commercial alcohol content must be adjusted by dilution with water and the provisions in article 6.1.1.1 in the cases that apply; possibly having an aging process of less than two months in oak or Encino oak containers.”

### ***Gold Tequila (Joven or Oro)***

“Product resulting of the mix between white Tequila with aged, extra-aged or ultra-aged Tequilas.” Also called Tequila joven or gold, this is the product that results from blending silver Tequila with any of the ingredients listed in NOM\_006 Section 4.1, in what is known as mellowing.

### ***Reposado***

A product which may be enhanced by mellowing, subject to an aging process of at least two months in direct contact with the wood of oak or Encino oak (holm or holm oak) containers. Its commercial alcohol content must be adjusted by dilution with water, as applicable. It should be noted that the result of blending Reposado tequila with Añejo tequila is considered añejo tequila.

### ***Extra-aged Tequila (Añejo)***

A product that may be enhanced by mellowing; subject to an aging process of at least one year in direct contact with the wood of oak (holm or holm oak) or Encino oak containers with a maximum capacity of 600 liters. Its commercial alcohol content must be adjusted by dilution with water. The result of blending extra-aged tequila with ultra-aged tequila is considered extra-aged tequila.

### ***Ultra-aged Tequila (Extra Añejo)***

A product that may be enhanced by mellowing, subject to an aging process of at least three years, in direct contact with the wood of the oak or Encino oak containers, whose maximum capacity is 600 liters. Its commercial alcohol content must be adjusted by dilution with water.

### ***Cristalino tequila (Aged tequila which is clarified through filtration)***

\* Not a legally defined category

See filtering on page 12

## **Classes of Mezcal: Section 4.5. Of NOM-070-SCFI-2016**

### ***Madurado en Vidrio “Matured in Glass”***

Mezcal stabilized in a glass container for over 12 months underground or in one space with minimal variations in light, temperature and humidity.

### ***Blanco or Joven***

Colorless and translucent mezcal that is not subject to any type of subsequent process. Note: Some mezcal requires a resting/oxidization period in order to obtain proper flavor. Traditionally, this was done in clay pots, but it is now typically rested in an inert glass, plastic or stainless steel container. The duration of resting varies and is based on the producer. Even if mezcal comes off the still at the proper flavor, it will get softer as it oxidizes.

### ***Reposado***

Mezcal that must remain for at least two months, but less than one year, in wood containers of any size, shape or capacity, with minimal variations in light, temperature and humidity.

### ***Añejo***

Mezcal that must remain more than 12 months in wood containers under 1000 liters, in one space with minimal variations in light, temperature and humidity.

Agave spirits, unlike many others, can noticeably change with exposure to oxygen. This is more commonly seen in the mezcal production, though tequila can react in a similar way.

# **FILTERING**

## **Tequila**

Filtering in tequila can be as subtle as sediment and particulate filters or as intense as an industrial carbon filter to remove as many impurities as possible. Many blanco tequilas are heralded by their marketing teams for their clarity. However, the primary drawback of filtering beyond particulate is for better or worse, flavor is removed. The following are the typical options in the tequila making process:

- Cellulose filters are typically used for the removal of sediment and any other particulate. They do not typically remove any flavors.
- Polypropylene filters can also be used for particulate.
- Ceramic filtration is another, more rare method. It does result in some flavor filtration and is a much finer particulate filter, therefore it can leave the tequila more transparent than a cellulose filter.
- Carbon Filtration can occur before or after barrel aging, and it occurs in varying degrees. In carbon filtration, the most subtle approach is by using drip filtration through charcoal in the Lincoln County process. The most aggressive method is pressurized filtration through industrial carbon filters.
- *If used before barrel aging*, the goal is to purify the distillate as much as possible, in a approach way to vodka.
- *If used after barrel aging*, the goal is to create a cristalino tequila. It should be noted that each cristalino tequila has its own approach, and can vary from color removal while retaining as much flavor as possible (though loss does occur) to vigorously filtering for clarity and “clean” flavors.
- Cold Filtration is used to remove fatty acids. Fatty acids contain flavor, however they can coagulate at cool temperatures, which some find aesthetically unpleasing, even though it is perfectly safe.
- Bentonite filtration is also used to clarify tequila in a similar way it is used to clarify wine.

## **Mezcal**

Usage of a particulate filter is typical.

## **Addition of Flavors**

Tequila: Mellowing (As specified in Section 4 of NOM-006-SCFI-2012)

“Procedure to soften the flavor of the tequila, through the addition of one or more of the following ingredients: Caramel coloring, natural oak or Encino oak extract (holm or holm oak extract), glycerin, sugar-based syrup.

Mezcal: Abocado con mezcal: Mezcal in which ingredients are directly incorporated to add flavor. Examples include maguey worms, damiana, lemon, honey, orange, and mango, among others, provided that they are authorized by the Agreement corresponding to the Ministry of Health (see 2.10), and as in the NOM-142-SSA1 / SCFI-2014 (see 2.2). Classes of Mezcal: Section 4.5.(e) ff NOM-070-SCFI-2016

## **Blending**

- Tequila may be blended for consistency.
- Mezcal, if blended, must be of the same category and class.

## **Proofing**

Tequila: When sold in the United States, tequila is typically diluted to 80 proof, and 76 proof when sold in Mexico. There is also high proof tequila.

Mezcal: Some companies will blend heads and tails back into the heart to obtain the proper ABV and flavor. Others will use water to bring the mezcal to proof.

## **Bottling**

### **Tequila:**

Some Tequila is bottled outside of Mexico. If this is the case, the company must be registered with the Tequila Regulatory Council, pursuant to the laws in 6.5.4 of NOM\_006\_SCFI\_2012.

6.5.4.2 The Tequila defined in Section 5.1.2 of this NOM may be bottled in bottling plants that are not a property of an authorized producer under the following conditions

6.5.4.4 The bottler who is not an Authorized Producer may only filter or dilute the Tequila with potable, distilled or demineralized water to obtain the commercial alcohol content of the Tequila within the parameters permitted under this NOM. Therefore, it may not age or mellow the Tequila.

## **Production Byproducts**

For every 0.750 liter bottle of mezcal, there are roughly 10 to 12 liters of vinasa (the liquid left behind) and 15 to 20 kilograms of bagazo (the spent agave fibers) left behind.

- Residual Solids: Spanish (Bagazo), English (Bagasso), French (Bagasse)
- Residual Liquids: Vinaza (Spanish), Vinasse (English and French)

## **Price**

Agave distillates can easily be more expensive to produce than many other spirits because it can be significantly more labor intensive. However, compared to other spirits which are made in developed countries, labor costs are lower.

# SOURCES AND SUGGEST READING

1. Zizumbo-Villarreal, Daniel & González Zozaya, Fernando & Olay-Barrientos, Angeles & Almendros, Laura & Flores-Pérez, Patricia & Colunga-GarcíaMarín, Patricia. (2009). *Distillation in Western Mesoamerica before European Contact*. *Economic Botany*. 63. 413-426. 10.1007/s12231-009-9103-6. [https://www.researchgate.net/publication/225621591\\_Distillation\\_in\\_Western\\_Mesoamerica\\_before\\_European\\_Contact](https://www.researchgate.net/publication/225621591_Distillation_in_Western_Mesoamerica_before_European_Contact)
2. (CRT), Consejo Regulador del Tequila. History. Consejo Regulador del Tequila. Accessed March 23, 2021. <https://www.crt.org.mx/index.php/en/el-tequila-2/history>.
3. Bowen, Sarah. "Case Study: Tequila." Food and Agriculture Organization of the United Nations, November 2008. <http://www.fao.org/fileadmin/templates/olq/documents/documents/Tequila%20mexico.pdf>.
4. Bowen, Sarah. "Case Study: Tequila."
5. Lachance, Marc-André. (1995). Yeast communities in natural tequila fermentation. *Antonie van Leeuwenhoek*. 68. 151-60. 10.1007/BF00873100. [https://www.researchgate.net/publication/14654965\\_Yeast\\_communities\\_in\\_natural\\_tequila\\_fermentation](https://www.researchgate.net/publication/14654965_Yeast_communities_in_natural_tequila_fermentation)
6. Nolasco-Cancino, Hipócrates et al. "Predominant Yeasts During Artisanal Mezcal Fermentation and Their Capacity to Ferment Maguey Juice." *Frontiers in microbiology* vol. 9 2900. 6 Dec. 2018, doi:10.3389/fmicb.2018.02900 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6291486/>
7. León-Rodríguez, Antonio & Escalante-Minakata, Pilar & Jiménez-García, María & Ordoñez-Acevedo, Leandro & Flores, Lola & Barba de la Rosa, Ana. (2008). Characterization of Volatile Compounds from Ethnic Agave Alcoholic Beverages by Gas Chromatography-Mass Spectrometry. *Food Technology and Biotechnology*. 46. [https://www.researchgate.net/publication/237336994\\_Characterization\\_of\\_Volatile\\_Compounds\\_from\\_Ethnic\\_Agave\\_Alcoholic\\_Beverages\\_by\\_Gas\\_Chromatography-Mass\\_Spectrometry](https://www.researchgate.net/publication/237336994_Characterization_of_Volatile_Compounds_from_Ethnic_Agave_Alcoholic_Beverages_by_Gas_Chromatography-Mass_Spectrometry)  
  
Lachenmeier, Dirk & Sohnius, Eva-Maria & Attig, Rainer & López, Mercedes G.. (2006). Quantification of Selected Volatile Constituents and Anions in Mexican Agave Spirits (Tequila, Mezcal, Sotol, Bacanora). *Journal of agricultural and food chemistry*. 54. 3911-5. 10.1021/jf060094h. <https://www.scribd.com/document/168223456/Quantification-of-Selected-Volatile-Constituents-and-Anions-in-Mexican-Agave-Spirits-Tequila-Mezcal-Sotol-Bacanora>
8. Auffrey, Richard. An Expanded History of Pechuga Mezcal, October 31, 2017. <http://passionatefoodie.blogspot.com/2017/10/an-expanded-history-of-pechuga-mezcal.html>.
9. Betts, Richard. "The Dirty Truth Of Making Mezcal And How We Can Do Better." Medium. Medium, March 16, 2017. <https://yobetts.medium.com/the-dirty-truth-of-making-mezcal-and-how-we-can-do-better-5fbdbd70e762>.

## Agave Genetics

Trejo, Laura & Limones-Briones, Veronica & Peña, Guadalupe & Scheinvar, Enrique & Vargas-Ponce, Ofelia & Zizumbo-Villarreal, Daniel & Colunga-GarcíaMarín, Patricia. (2018). Genetic variation and relationships among agaves related to the production of Tequila and Mezcal in Jalisco. *Industrial Crops and Products*. 125. 140-149. 10.1016/j.indcrop.2018.08.072. [https://www.researchgate.net/publication/327688005\\_Genetic\\_variation\\_and\\_relationships\\_among\\_agaves\\_related\\_to\\_the\\_production\\_of\\_Tequila\\_and\\_Mezcal\\_in\\_Jalisco](https://www.researchgate.net/publication/327688005_Genetic_variation_and_relationships_among_agaves_related_to_the_production_of_Tequila_and_Mezcal_in_Jalisco)

## Tequila History

For more insight into the history of tequila, read Bowen's book: *Divided Spirits: Tequila, Mezcal, and the Politics of Production* (California Studies in Food and Culture Book [https://www.amazon.com/dp/B0132ICWPW/ref=dp-kindle-redirect?\\_encoding=UTF8&btcr=1](https://www.amazon.com/dp/B0132ICWPW/ref=dp-kindle-redirect?_encoding=UTF8&btcr=1))

## Insight into the diffuser:

- Nuñez, Roberto Carlos. What Is a Diffuser and How Does it Work?, May 24, 2018. <https://www.casasauza.com/tequila-process/what-is-diffuser-how-does-it-work>. [www.casasauza.com/tequila-process/benefits-gentle-extraction-process-agave-sugar](http://www.casasauza.com/tequila-process/benefits-gentle-extraction-process-agave-sugar)
- Nájjar, Rodrigo. Benefits of the Soft Extraction Process of Agave Sugars, May 22, 2018. <http://www.casasauza.com/tequila-process/benefits-gentle-extraction-process-agave-sugar>.

### **ADDITIONAL RESOURCES**

Tequila Regulatory Council  
[www.crt.org.mx/index.php/en/](http://www.crt.org.mx/index.php/en/)

Council Regulatory Mezcal  
[www.crm.org.mx/](http://www.crm.org.mx/)  
[www.mezcal.com/en/home.php](http://www.mezcal.com/en/home.php)

Agave Spirits Blog  
[www.mezcalistas.com/blog/](http://www.mezcalistas.com/blog/)

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