

## ARTISANAL MEZCAL IN PUEBLA: LOCAL STAKEHOLDERS AND KNOWLEDGE

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### ABSTRACT

The objective of this study was to explain the local understanding and knowledge of mezcal producers. The methodology was qualitative: in-depth interviews and participatory observation were used, which allowed a holistic view of the dynamics of mezcal production as well as approaching ancestral stakeholders and knowledge. Data collection from a sample of 42 production units and eight communities was conducted using the snowball method. The producers are 51 years old on average, 70% of them with education of 9 years or less, and they keep a strategy of multiple activities to generate their income: 63% sell mezcal and combine farming and non-farming activities (37%). Mezcal elaboration (artisanal and ancestral) has five processes: agave harvesting, cooking, fermentation, distillation and bottling. The workforce is mainly family members. The activity is carried out by fourth generation producers, 74% of them belong to an organization, and 88% participate in two or more stages of the agave-mezcal chain, where local understanding and knowledge are an essential part of the subsistence and permanence strategies of the households in the territory studied. Support policies, which have been scarce until now, are necessary to strengthen the permanence of mezcal elaboration as generator of social welfare, as well as conservation of the genetic resource, agronomic research, commercial training, and service provision to the communities.

**Keywords:** adding value, ancestral knowledge, mezcal agave.

### INTRODUCTION

The elaboration of spirit drinks represents the essence, culture and ancestral knowledge of indigenous peoples. In the case of mezcal, the organoleptic notes are given primarily by its raw material, its elaboration process and the region of origin (Hernández, 2017). The domestication and use of *Agave* in Mesoamerica represents a source of food, fiber production, fermented beverages (*pulque*), non-fermented beverages (*aguamiel*), and distilled beverages such as mezcal (Colunga-García *et al.*, 2017). The word mezcal was known as *mexcalli* (cooked maguey) while other studies refer the term *meztli* (moon) and *calli* (house), meaning “house of the moon” (CNDPI, 2015). The evidences found of the crop and production of this distilled beverage refer back to the years 400 and 600 BC, in the Xochitecatl-Cacaxtla sites, in Tlaxcala (Serra and Lazcano, 2011). In this context, the use of maguey plants in the Guilá Natquiz cave in Oaxaca, and in Coxcatlán, Puebla, has an antiquity of 6500 years BC; the latter is located in the Tehuacán-Puebla valleys (Sánchez, 2017). However, the origin of agave distillates is debatable; in this regard, Colunga-García *et al.* (2013) showed evidences of the existence of the “wine-mezcal” region since 3500 years ago in southern Colima and Jalisco, which includes the entire north and center-south zone of the country; coconut wine and mezcal were traded (De León, 2015).

**Citation:** García-Benítez E, Jaramillo-Villanueva JL, Vargas-López S, Bustamante-González A. 2024. Artisanal mezcal in Puebla: local stakeholders and knowledge. *Agricultura, Sociedad y Desarrollo* <https://doi.org/10.22231/asyd.v21i3.1605>

ASyD 21(3): 330-347

**Editor in Chief:**  
Dr. Benito Ramírez Valverde

Received: May 3, 2023.  
Approved: August 28, 2023.

**Estimated publication date:**  
June 17, 2024.

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This explains the importance of mezcal elaboration in the economy of the indigenous and mestizo populations of the producing zones (García, 2014; Colunga-García *et al.*, 2017). The knowledge of the productive process of artisanal mezcal was formalized with the legalization of the agave alcohol (tequila) in the 19<sup>th</sup> century (Torres *et al.*, 2015). In the mid-20<sup>th</sup> century, after the Mexican Revolution, the mezcal production process began in the state of Puebla with the use of distillers abandoned by the Spanish Hacienda owners and used by the community inhabitants (González, 2021); at the same time, this productive process is transmitted from one social stratum to another and from generation to generation. This is how a fourth generation mezcal master from San Nicolás Huajuapán describes it: "...His grandfather learned from his father and worked with clay pots; mezcal, back then, was worth 40 cents per liter, it was sold in small stores or in the town's fairs; and wild maguey was extracted from the hills, transported on donkey back, ground by mallet, and fermented in a hide."

Ancestral and traditional knowledge of the artisanal process in mezcal elaboration requires revaluation, inclusion and preserving local and ancestral practices and knowledge. It is essential to identify, describe and explain the techniques, attributes and methods that add value to the mezcal, with the intention of contributing to their conservation, recognition and valuation by consumers. The elaboration of this distillate in the last 10 years has become a benchmark for rural family economy in the state of Puebla (Llaven, 2022).

In the state of Puebla, the agave-mezcal productive chain started to be promoted since the year 2000, and it has advanced in its consolidation by obtaining the Designation of Origin (DO) in late 2015, established in the *Diario Oficial de la Federación*, as a result of complying with the requirements established in Articles 159 fraction I to III and 166 of Intellectual Property, where it is requested to include 115 municipalities from the state of Puebla in the DO (DOF, 2015).

*Tequila shows you the heart of Mexico,  
but mezcal shows you its soul.*

Popular proverb in the study region.

## THEORETICAL FRAMEWORK

### Traditional knowledge and local understanding

Local understanding or indigenous knowledge is defined as the innate knowledge of human beings, a life philosophy of indigenous peoples, of practices and techniques acquired throughout time, linked to the human-nature relationship, the environment, worldview and society (UNESCO, 2017). Traditional knowledge is knowledge transmitted from generation to generation, developed from the experience acquired throughout the centuries and adapted to the local culture and environment. Traditional knowledge tends to be collective property and takes the form of traditions, cultural values, beliefs, rituals, community laws, local language, and agricultural practices (Naciones Unidas, 2013). In this sense, Hernández (2022) points out that local traditional knowledge and

understandings allow the coexistence with nature and society, since they represent the basis of the local economy.

In this context, knowledge of the *in situ* management of agave and mezcal production is based on the knowledge, peasant experience and innovation, linked to satisfying a need rather than a profit (Martínez-Molina and Solís-Espallargas, 2020). Such is the case of artisanal mezcal in the state of Puebla, which is presently considered a *premium* product. In this sense, there is shared and differentiated knowledge that depends on certain components, such as: characteristics of each region, worldview, raw material, biodiversity, reciprocity, elaboration process, and family workforce.

To approach the context of the peasant family economy on the consumption and production of artisanal mezcal, the theory of peasant economy was used. In this regard, Santacoloma-Varón (2015) describes that peasant economy, constitutes a form of organization of production and consumption based on a balance that contributes to the subsistence of the family nucleus. The dynamics of the peasant family economy are characterized by production fundamentally for auto-consumption, family workforce, subsistence and unpaid work (Rendón, 2012). Likewise, they point out that socioeconomic characteristics have an impact on the peasant family unit and which, in combination with the factors of production, land, work and capital, generate a productive system of auto-consumption and over-exploitation that is not efficiently remunerated. Under this premise, Plascencia de la Torre and Peralta (2018) state that the elaboration and sale of mezcal generate asymmetry between the artisanal and the industrial, evidencing the disadvantages (value transference) of the first in the production and commercialization chain.

Because of the aforementioned, economic diversification between rural families takes place directly through product exchange (barter), auto-consumption, and local trade. In this context, Camacho *et al.* (2019) highlight the collective nature of family work implicit in artisanal products as differentiated products that indicate tacit knowledge and a unique quality.

Currently, the consumption trends demand sustainable and traditional products with genuine and authentic flavors. Understanding the process and work behind a mezcal bottle deserves recognition of the value of the “artisanal” and “local” attribute. In this sense, Espejel (2019a) expressed that the consumer requires innovative products that do not compromise the sensorial essence provided by its authenticity. Such is the case of mezcal, beverage rich in tangible and intangible attributes, derived from the type of process, the biodiversity of its environment, the maturation time of the agave, the type of firewood used, the soil, the water and the touch of the mezcal master, which make this beverage an authentic elixir free of conservatives and additives. This shapes a potential source of added value for consumers and possibilities for a better retribution to mezcal producers.

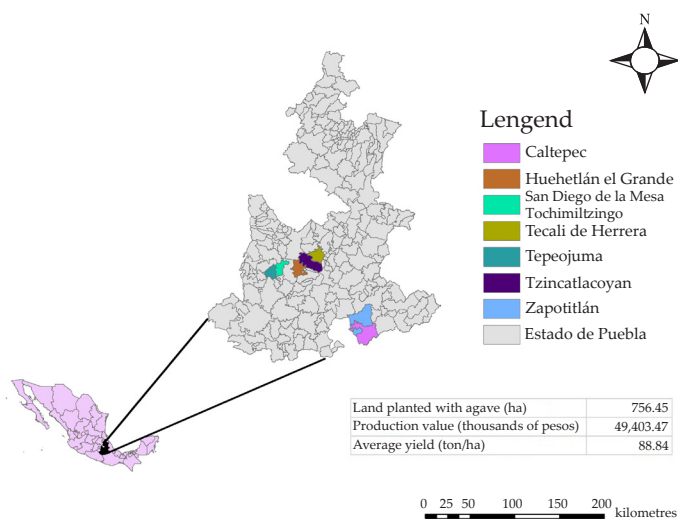
From this context, the “artisanal value” is founded more on quality than on quantity, since it is elaborated on a small scale and with processes and understandings that confer it authenticity. In this sense, Infante (2016) expressed that the processing of artisanal products is characterized by a series of tangible and intangible attributes such as land, technology, tools and utensils, workforce and knowledge, among others.

The importance of communicating the artisanal attribute is that products processed, bottled and labeled this way generate value and willingness to pay in the consumer (Viegas *et al.*, 2014). Added value is defined by IICA (2014) as “The difference between what it costs to place a product in the market with specific characteristics and what the productive process generates as differentiated value”. In this sense, the attribute of origin refers to a Geographic Indication (GI) or a Designation of Origin (DO), as is the case of the production of artisanal mezcal. The objective of this study was to describe and explain the tacit ancestral and traditional knowledge of the productive process of mezcal in the state of Puebla, with the aim of identifying opportunities for adding value, which could improve the family economy of mezcal producers.

### METHODOLOGY

The study was carried out in the municipalities of Tecali de Herrera, Tepeojuma, San Diego la Meza Tochimiltzingo, San Juan Tzicatlacoyan, Zapotitlán and Caltepec in the state of Puebla (Figure 1), located on coordinates 20° 50' - 17° 52'° N, 96° 43' - 99° 04'° W. The mean annual temperature is 17.5 °C, minimum 6.5 °C and maximum 28.5 °C. The state of Puebla converges in the Mixteca region which includes the states of Oaxaca, Guerrero and Puebla. The agave production zones are located in the altitudes that range from 1,200 to 2,300 m.

In the study area there are traces of speakers of Náhuatl, Totonaco, Mazateco, Mixteco, Zapoteco and Popoloca (INEGI, 2020), who reside in different sociodemographic and economic contexts. According to figures from CONEVAL's annual report (2020), the municipalities show a high degree of marginalization and medium-high social backwardness



Source: prepared by the authors based on survey data, 2021.  
**Figure 1.** Map of the study zones.

at the municipal level and high at the state level. Educational backwardness in the municipality of Caltepec represents 34.4% of the population, while in Tochimiltzingo it reaches 42.4%, Huehuetlán el Grande 33.3%, Tecali de Herrera 19.2%, Tepeojuma 35.1%, Tzicatlacoyan 35.6%, and Zapotitlán 29.4% (Secretaría del Bienestar, 2021). The economic activity of the producers from the municipalities of this study is characterized by small-scale trade; in Caltepec it is 45.2%, Tochimiltzingo 43.2%, Tepeojuma 40.9%, Huehuetlán el Grande 54.1%, Tecali de Herrera 49.1%, and Zapotitlán 30.4%. The manufacturing industry is the second activity in importance, for the municipalities of Caltepec (38.1%), Tochimiltzingo (29.7%), and Tecali de Herrera (29.9%) (INEGI, 2019; Secretaría de Economía, 2022).

In the case of Tzicatlacoyan, the main economic activity is manufacture (87.0%) and in second place, retail trade (10.9%). Tepeojuma presents as second relevant activity lodging, food and beverage (25.4%), and in third place, the manufacturing industry (17.2%). For the municipality of Zapotitlán, its main economic activity is mining (26.2%), and in the third place, the manufacturing industry (19.0%). Huehuetlán el Grande, in addition to retail trade, has the manufacturing industry as second activity (15.3%) (Secretaría de Economía, 2022).

The wild agave surface in the state of Puebla is 250 mil ha, with an average yield of 84.3 tons per ha (SIAP, 2020). From these, 580 ha correspond to commercial agave plantations, distributed in the communities of San Diego la Mesa Tochimiltzingo, Huehuetlan el Grande, Cuantinchán, Chiautla, Chietla, Tecali de Herrera, Tzicatlacoyan, Xochitepec and Caltepec (Jiménez, 2017; Axayacatl, 2022).

### **Information gathering**

The research is qualitative, analytic and descriptive. The techniques used for data collection were participant observation, in-depth interview, with the use of a semi-structured questionnaire, applied face to face to small-scale mezcal producers and key informants, in recurring visits in the communities and mescal distilleries (*palenques*).

Directed sampling with 42 key informants was applied, among the producers who are members of mezcal organizations in the state of Puebla. For the organized and detailed record of ancestral knowledge about mezcal elaboration, in-depth interviews were used. Following the proposal by Robles (2011), in the first stage, the survey respondents were approached and the data were gathered and recorded; descriptive, structural and contrast questions were used for this purpose. The interpretation and analysis of the information took place during a second stage.

There were three questionnaire sections: the socioeconomic section included the sociodemographic characteristics of the leader of the production unit (PU) and members of the family, sources of income, generational replacement. The section of agave harvesting and productive process considered the land surface, land tenure, type of agave, management of plantations for agave production, use of inputs, associated costs, and institutional backing received. The section of the mezcal elaboration process included agave stockpiling, milling, fermentation, distillation and bottling, trading and certification.

The use of participant observation was justified because in order to understand the ancestral knowledge of mezcal elaboration in depth, a daily and reiterated approach to the spaces where productive processes take place and to the different stakeholders involved was necessary. The recommendations by Bracamontes (2015) were followed, who points to four stages: “finding the scenarios, entering, accessing study zones, and staying and leaving the study zones”. The use of participant observation was utilized while recording the process of mezcal elaboration, such as the techniques used in the processes, inputs, instruments, equipment, and utensils used in each stage, the workforce, the costs associated to each process, and the management of residues from the mezcal elaboration process. Knowing the reality of the community construct contributes to understanding and explaining better the context where the social actors reproduce their social life (Bello-Vidal *et al.*, 2019). In this direction, a semi-structured survey was applied with key informants (local authorities), which allowed documenting the situation of social organization, relevant economic activities, educational, health and public service infrastructure, and assessing community integration and participation of the communities and municipalities in this study.

#### **Data analysis**

The first step of the analysis consisted in classifying the interviews with complete, legible and correct labeling. Then, codifying in Excel, which consisted in concentrating all the data that refer to themes and concepts of the study and analyzing them (Robles, 2011). To better comprehend and systematize the information, diagrams, tables, graphs and drawings were used that allowed finding patterns and categories to describe and explain the production process of agave and mezcal, the sources of income, trade, characteristics of social actors, and the context where these processes are conducted. For the quantitative variables, descriptive analysis was carried out with the software SPSS version 23.

### **RESULTS**

The results showed that 92.9% of those who manage and operate the *palenques* (production units) are men and the rest are women, although it was seen that the woman participated in every processes of mezcal elaboration. The family nucleus is made up by four members on average. The age of the survey respondents was 51 years, with a minimum of 30 and maximum of 78 years. In addition, 91% are Spanish speakers, and 9.52% speak Náhuatl in addition to Spanish (Table 1). It was seen that the predominant educational level was primary (35.7%) and secondary (33.3%), while 16.7% have high school, and the rest (14.3%) has undergraduate studies.

#### **Productive activities**

The pluriactivity of agave producers involves work inside and outside the farm; 78.6% are devoted to farming activities and 21.4% to non-agricultural activities; the latter is more evident in those who have more education. The diversification of activities is characterized by two fundamental aspects: auto-consumption activities and sale of surplus.

**Table 1.** Socioeconomic system of agave production.

Characteristics of the production units	Percentage	Characteristics of the production units	Percentage
Education of the leader		Surface	
1.Primary	35.7%	1.Less than six hectares	81.0%
2.Secondary	33.3%	2.From seven or more hectares	19.0%
3.High School	16.7%	Origin (agave grown)	
4.Undergraduate Studies	14.3%	1.They use a plant from the region	7.1%
Extra-plantation activities		2.They use plant from other municipalities	33.3%
1.Agricultural activity	54.8%	3.They bring plant from Oaxaca's Mixteca region	50.0%
2.Commercial sector	26.2%	4.They bring plant from other states	9.5%
3.Trades	7.1%	Origin (wild agave)	
4.Worker	11.9%	1.They get it from the wild	45.2%
Productive activities		2.They buy it from land owners	33.4%
1.They clean the land	100.0%	3.They pay a permit to the commissary	11.9%
2.They clear and plough	95.2%	4.They do not use wild agave	9.5%
3.They buy plant	76.2%	Land tenure	
4.They apply fertilizer	38.1%	1.Private	11.9%
5.They apply compost	100.0%	2.Ejido	42.9%
6.They conduct manual weeding	69.0%	3.Communal	45.2%
7.They trace contour lines	7.1%	4.They rent the land they sow	21.4%
Workforce in the PU		They are part of a formal organization	59.5%
1.Family	19.0%	They speak an indigenous language	9.5%
2.Hired	33.3%	Generational replacement	90.5%
3.Both	47.6%		

Source: prepared by the authors from survey data, 2021.

Among the strategies of social reproduction used in the diversification of income, in addition to mezcal production, 54.8% of the land owners carry out agricultural productive activities, 26.2% manages small shops for local sale and consumption, 11.9% work as employees or workers, and the rest of the producers have a trade that allows them to contribute extra income for family sustenance (7.1%) (Table 1). The farming activities are based on family agriculture and the main crops found are corn 54.2% and bean 12.5%, mainly for auto-consumption; also pitahaya 4.2% and mezcal agave 29.2%.

In the context of the agave-mezcal productive chain, 11.9% of the interview respondents declared being devoted to the production and sale of agave as primary activity.

#### **Agave harvesting and production process**

Most of the producers (81%) have six hectares or less of land surface and the rest have more than six. In Puebla, 45% of the surface sown with agave is communal property, 43% *ejido*, and 12% small property. Harvesting of wild agave is carried out in the early morning, after recognition of the zone when a loading point is established. Next, a distance between

500 and 1,000 m around is visited, depending on the availability (density) of agave. Later, once the maguey is selected, the sign of the holy cross is made on the first head, for the harvest to be good during the entire day. Then, the agave is cut and the resulting head is transported to the loading point. The most frequent is that 2 to 4 loads (trips) are cut per day, if it is done by two people. One load is equivalent to 100 to 150 kilos of agave, if it is wild espadilla (*zacametle*) or papalometl. In addition to the variety, it also depends on the zone and the weight of the maguey cone. In that sense, a producer describes: *“in the process of agave cutting, it is only two of us, my father and I; to gather a ton of maguey, we need to go to the hill five days per week”*.

In the *jima* (cutting) of the wild agave jabalí, pitzometl, papalometl and espadilla, a producer from Caltepec mentions the following: *“If the wild agave is small, two people are needed, but if the maguey is large, we need four people and between 25 and 50 cones are gathered per day”*.

#### **Agricultural production practices**

The production of cultivated agave begins with the selection and cleaning of the land. This task is carried out by all the interview respondents; 85.7% do it manually and 14.3% mechanized. Then, primary farming tasks are done, which involve breaking at a depth of 20 cm or more vertically. Then, ripping or plowing is conducted; 95.2% of the survey respondents do it, and the rest pointed out that they do not carry out this practice.

In the study region, propagation of plant material is carried out in three ways: through shoots and bulbs (asexual), by seed (sexual), and by pollination. The first form of propagation is the most practiced.

As a way of preserving the maguey species, propagation is also done through small greenhouses established by the producers from the municipalities studied. The selection of shoots and offshoots is conducted in plantations of 1 to 3 years, where it is verified that they are free of pests and diseases (*tostoneo*), with sizes of 9, 10, 12 and 14 cm. A 3 to 4 cm piece of rhizome is left for its transplant. The months of sowing are January to June. The plantation density depends on the characteristics of the plot, the slope and the variety required. The densities found range from 500 to 1,000 (7.1%), from 1,000 to 2,000 (26.2%), from 3,000 to 4,000 (59.5%), and more than 4,000 (7.1%).

In relation to the type of trace, 66.7% of producers have linear furrows and 7.1% have contour lines. Of the producers, 26.2% stated that their farmlands have moderate to high inclination. Controlling weeds must be done once or twice per year; it was found that 69% of the producers do and the remaining 31% does not resort to this practice. Only 38.1% supplement the plant's nutrients with the application of organic fertilizer and 61.9% of the producers do not.

*The older the maguey,  
the more stories the mezcal tells.*

Popular saying in the study region

### Mezcal elaboration

Most producers of agave and mezcal belong to a producers' organization, with the aims of production or commercialization (74%), and 26% work individually. An aspect to highlight is that not all mezcal producers have a *palenque*; however, they rent it from someone in the organization and carry out payment with work and with liters of mezcal. The elaboration of artisanal mezcal has the following stages:

**A) Agave extraction in the field.** Once the plant to be harvested is selected, it is cut with machete, with crowbar and hoe. This practice is carried out in the months of November to May. Regarding the origin of the agave, 38.1% of the producers manifested they obtain the wild agave directly from the hills, 33.3% buy it directly from the owners of plots or expanses, 12% from permission of the *ejido* commissary or local authority, 4.1% by purchasing from outsiders, and 7.1% through the mediation contract system. In the case of cultivated agave, 7.1% obtain it from the region itself, 33.3% obtain it from other municipalities, 50% get it from Oaxaca's Mixteca region, and 9.5% from other states. Then, it is transported to the *palenque* where it will be processed. In the *palenque*, the cones are marked to differentiate the agaves. The most used varieties are espadín (50%), tóbala (31%), pitzometl (9.5%), as well as wild varieties from the region: arroqueño (2.4%), espadilla (16.7%), potatorum (61.9%), cupreata (2.4%) and pitzometl (16.7%).

**B) The process of cooking the agave cones.** Conical volcanic rock (*tezontle*) ovens and cavities without lining are used. The average capacity of the ovens found was 2.65 ton; 42.9% of the mezcal producers mentioned having ovens with capacity of 4 to 6 tons, 21.4% with 7 to 9 tons, and 21.4% mentioned a volume between 10 and 12 tons as maximum and less than 3 tons (4.8%). In the oven, thin firewood (*mecha*) is placed at the back, to ease the fire, and the firewood is burned between 6 and 7 hours; once lit and hot, the stones and damp husk are placed as insulation, and then the maguey is piled on, cut in half, and covered with palm mats, ribs, husks, rubber or tarpaulin, banana leaves, sand and soil.

In this stage, there is the custom of placing a cross when the oven is covered. This is how a mezcal master explains it: "...Once the oven is covered, we place a cross and we make the sign of the holy cross on the oven and we say, in the name of God, may it all be good; we place the cross as a sign of gratitude to the land and to the heart of the agave".

The number of days per cooking can be 3 to 10. This stage is vital, since the *tatemado* (roasting) allows the transformation of inulin, which is a monosaccharide that contains fructose and glucose from which the sugars are obtained (Gómez-Zamora *et al.*, 2016). The firewood most frequently used for this process is palo blanco, palo dulce, guamúchil, mezquite, pino, huaje, coatillo and sabino. Each cooking, one to two tons of firewood are used on average. However, the forest biomass from each region is also used, such as shrubs and dry trees.

**C) Milling.** After the maguey has been cooked (*tatemado*), it is left to rest for one or two days, to later be ground and pulped using the mallet or mill. This process allows the

extraction of sugars (juice from the cones). In the case of milling with mallet, it can last between four and five hours by fermented hide, that is, using four employees per day. In the case of manual milling, with the use of mallet, it depends on the amount of agave and the number of employees. With the use of the mill, it is done on average of three days' time, since the traction is carried out by horse or mule (Figure 2).

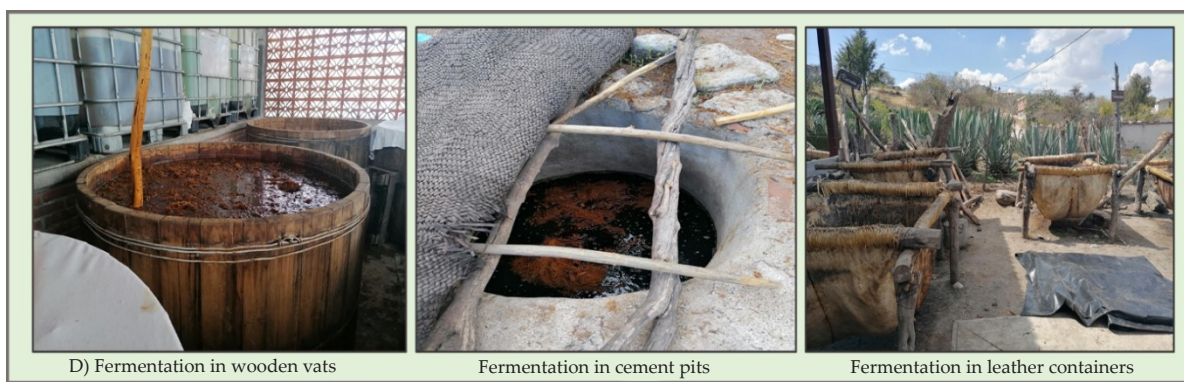
**D) Fermentation is carried out with well or spring water.** This stage is characterized by the conversion of sugar to alcohol. After milling, the agave is placed in wood vats with capacity of 1,000 to 1,200 kg, where on average 600 kg of agave are placed per 500 liters of water. Later, the dry fiber is placed in the vats and left there for 3 days without water, so it can begin to get warm. Next, water is added and mixed (Figure 3). The differences in the use of equipment used can be a trigger in the reduction of time and the flavor of the fermented must.

Likewise, the use of the ceramics distiller, the aroma and the flavor of the clay in combination with the sugared must, give more sensitivity to the mezcal process. The number of days of fermentation depends on the knowledge and technique of each mezcal master. It can be from 3 to 12 days. When the yeasts ferment, they generate heat and give off carbon dioxide, as sign of a chemical reaction that turns sugar into alcohol (Figure 3).

**E) Distillation.** Mezcal masters call this phase the “thread of patience” due to the time used in the process. After fermenting the fibrous residue (*gabazo*), the must obtained is transferred to the distiller, sealed with pulp and moist bagasse; there is use of the copper and clay distiller (Figure 4). The fermented must with *gabazo* is placed in the still, with an



Source: prepared by the authors from survey data, 2021.  
**Figure 2.** Process of mezcal elaboration.



Source: prepared by the authors based on survey data, 2021.  
**Figure 3.** Fermentation process.

average capacity of 250 to 300 ml. The vapors are condensed in the coil and, finally, a first distillation is obtained that is called *xixe* (common or ordinary).

The first distillation lasts 3 to 4 hours. The second distillation produces the elixir known as mezcal, the tips (with higher alcoholic graduation), tails or hearts (graduation lower than 20°), and the *ingüishe* (wine) are separated. The magic of the pearly stage indicates the alcoholic degree, as expressed by a mezcal master from Tepeojuma: “The grandfathers would taste the mezcal with a small gourd and a straw (Venecia), and if the bubbles are large it is paired at between 60 and 70 degrees of alcohol”.



Source: prepared by the authors based on survey data, 2021.  
**Figure 4.** Distillation process.

That is, the size of the bubble, the time it lasts, and the way in which it disappears is what the mezcal masters call the pearly cord, indicating the quality of the mezcal. As a relevant piece of data, from 100 to 120 liters of mezcal per ton of agave are obtained on average. The entire process, from agave harvesting to the moment when the last distillation is carried out, requires between 20 and 25 days to obtain the mezcal (Table 2).

### Characteristics of the municipalities and communities of study

The productive activity of mezcal, in the opinion of the interview respondents, develops in marginalized municipalities and localities of the state of Puebla, with limited public services and infrastructure. Territorial rootedness is a characteristic of social groups that reside in rural areas. In this regard, 37% have been residing in the municipality for 30 years or more, 38% of the locals are between 20 and 30 years old, and 25% mentioned they are less than 20 years.

### Service provision

Regarding the food supply in the communities of study, 54.2% of the survey respondents referred that it is good, 42% average, and 4.2% considers it bad. In this same context, regarding access to health services, 54.2% were of the opinion that access is average, 33.3% good and the rest very good (Table 3). In terms of sufficiency and conditions of roads and highways, 29% manifested that they are enough and in good conditions, 50% that they are insufficient, and 21% thought that they are insufficient and that those available are in bad conditions.

### Financial sector and backing

Support from public policy in the localities in 2022 reached 87.5% of the interview respondents, who received some type of backing from public programs, mainly from the

**Table 2.** Summary of the mezcal elaboration process in the study zone.

Process	Experience of the producer	Cutting/Jima	Roasting (Tatemado)	Defibering	Fermenting	Distilling	Type of mezcal
Ancestral	Third generation	Manual with machete, crowbar or hoe	Stone oven	Manual with mallet	Leather vats	Clay pot (Bocoya)	Young (white)
Artisanal	Third, fourth and fifth generation	Manual with machete, crowbar or hoe	Conical stone and brick ovens	Ripper Mill Mallet	Wood, cement, plastic vats and cement wells	Copper distiller	Young abocado Mature black
Industrial	Third and fourth generation	Manual with machete, crowbar or hoe	Conical stone and brick ovens	Mill	Stainless steel vats	Copper distiller	Young (white)

Source: prepared by the authors based on survey data, 2021.

**Table 3.** Level of satisfaction of basic needs in the study zone.

	Very bad	Bad	Average	Good	Very good
Availability of foods			41.7%	54.2%	4.2%
Access to health services	4.2%	4.2%	54.2%	33.3%	4.2%
Housing			62.5%	33.3%	4.2%
Access to education		8.3%	37.5%	50.0%	4.2%
Availability of drinking water	8.3%	12.5%	41.7%	37.5%	
Access to the internet	4.2%	8.3%	58.3%	25.0%	4.2%
Infrastructure	4.2%	16.7%	50.0%	29.2%	

Source: prepared by the authors based on survey data, 2021.

programs for the elderly and production for welfare. In the financial area, all the survey respondents said they do not have credit in their communities. However, as a financial alternative, 29.2% use savings banks that operate in their communities.

#### **Environmental problems and migration**

The main environmental problems mentioned by interview respondents were the generation and management of garbage (72%), forest deforestation (63%), and plant and animal extraction (58.3%). Migration to the United States was reported as a problem by 92% of the interview respondents, who state that this generates a lack of workforce in the communities.

#### **Technical assistance, training and research**

Backing from government institutions through public programs is fundamental to support the development of the agave-mezcal chain. The interview respondents manifested that they received assistance about the agave and mezcal production process (26%) and about the export process (14%). The services of technical assistance and training were granted by technicians who are agave specialists, distributed in the regions of Tehuacán, Tecamachalco, Tepexi, Tepeaca, Atlixco and Izúcar de Matamoros (Secretaría de Desarrollo Rural del Estado de Puebla, 2022).

Regarding agronomic studies, the producers do not have knowledge of studies in their municipalities or on the mezcal production process or any aspect of the agave-mezcal chain. However, documental information reveals that institutions such as the Centro de Investigación y Asistencia en Tecnología y Diseño del Estado de Jalisco (CIATEJ) and CONACYT have conducted various inquiries in matters of plant health, biotechnology, agro residues and other areas (Vázquez, 2018).

### **DISCUSSION**

Sociodemographic characteristics of the managers and owners of the *palenques* are similar to those in the rural areas of Puebla; the average age of the interview respondents of 51 years is younger than the average reported by Jaramillo-Villanueva *et al.* (2019) for the

rural population in the state of Puebla. This can be because, in contrast to other farming activities, mezcal production has generational replacement, which implies that young people are entering the activity continually. The average age of education is 9.2 years in Puebla (INEGI, 2021) and 8.9 years in the study region. The study region also presents more education than that reported by Bautista and Terán (2008), for mezcal producing regions in Oaxaca, who found that the owners of *palenques* have primary school level. Women's participation as owner or manager is 7%; however, it was seen that they participate in every process in mezcal elaboration, directly as responsible of some stage of the process, but also in the supervision of other processes. This is emphasized by López (2014), who argues that out of every person who participates in the maguery and mezcal chain, 60% are men, 30% women who are devoted to assisting in the process and 10% are women who would be the leaders of the mezcal production.

#### **Productive activities**

Producers of agave and mezcal carry out other productive activities to complement the family income, which denotes that there is a margin of specialization and that they do not devote themselves to this activity for the whole year. In this sense, Atkinson *et al.* (2014) point out that productive diversification as a reproduction strategy includes sustainable attributes, such as the search for economic viability of the business, food production in their lands, both for sale and for auto-consumption and the preservation of local knowledge. These results are in consonance with what was reported by Vega and Pérez (2017), who highlight that 84% of the mezcal producers complement their income with other productive activities.

#### **Agave harvesting and production process**

Most of the producers (81%) have six hectares or less of land surface and the rest have more than six. Regarding this point, Espejel *et al.* (2019b) found in their study about agave and mezcal in three municipalities of Oaxaca that producers have on average 5 ha. In the municipalities and communities where this study was carried out, 88% of the surface where agave harvesting is performed is communal property and *ejido*, which is why the extraction of agaves is not always regulated and, when it is, the regulations are not always followed, which could generate excessive extraction; in the medium term, this places at risk the sustainability of these systems. Regarding this point, Janssen *et al.* (2019) argue that different studies show that communal property doesn't necessarily lead to the degradation of the common natural resource, because the users have created institutions to rule their own resources.

#### **Agave production practices**

Regarding the type of trace, most of the producers use a linear furrow trace, which promotes soil erosion. This practice requires urgent attention by the technical assistance programs. About this aspect, Herrera-Pérez *et al.* (2018) point out that contour lines are

an infrequent practice in the agave plantations, which only 24% of the producers carry out. Concerning propagation, in the study region, the propagation of plant material is conducted fundamentally through shoots and small bulbs (asexual). This is sustained by Reynoso-Santos *et al.* (2012) who, in their study of agave taxonomic identification, point out that there are still no studies and techniques of the sexual reproduction of agaves which generate acceptable results.

### **Mezcal elaboration**

The analysis of the artisanal mezcal elaboration process showed that there is heterogeneity in each of the processes, from cooking, milling, fermentation, distilling and bottling. This is positive, in the sense that each particular process contributes particular characteristics to the final product, which could be a source of value adding, adequately transmitted to the consumer. However, Pérez *et al.* (2016) argue that there is no research about compounds that confer a distinctive signature to each mezcal, specific to an agave, region or processing, which would allow elucidating authenticity and differentiation tests of the different mezcal zones. This suggests that under a scenario of growing national and international demand, a chemical and microbiological characterization is necessary, as well as the type or types of agave in each local process used.

### **Institutional backing**

Backing from government institutions, through public programs, is fundamental to support the development of the agave-mezcal chain. In Puebla, especially since the inclusion of 70 municipalities in the designation of origin of mezcal, agave and mezcal producers have received attention from public programs. However, some essential backing to support the growth of the activity are insufficient, for example, formal credit does not exist. Around 30% of the producers use credit from savings banks. Regarding this aspect, Cuevas *et al.* (2019) state that 11.4% of the subsistence producers and 10% of the producers of low productive scale in agave production have some type of financing. In addition, Baustista and Terán (2008) state that agricultural production and mezcal are not foreign to this, being financed by remittances, and by social public backing.

Backing from government institutions through public programs is fundamental to support the development of the agave-mezcal chain. The interview respondents stated that they received assistance for the production process of agave and mezcal (26%). Technical assistance is given by technicians from the Ministry of Rural Development in Puebla (SDR, 2022). The technical, social and economic research does not reach producers. The producers do not have knowledge of agronomic studies or about the mezcal production process, although various institutions have conducted research in different aspects of the productive process (Vázquez, 2018). This denotes insufficient dissemination of the research results. Regarding this point, Iglesias and Carreño (2017) argue that in order for the public policy to be effective, it must consider mechanisms that imply management of natural resources, innovation, the market, training, technical assistance and transference of technology, as well as the creation of productive infrastructure and financing.

## CONCLUSIONS

The agave production system is characterized by being for family subsistence; communal land ownership predominates with surfaces smaller than 6 ha, plantation densities of 3,000 plants per ha, low use of fertilizers, generalized use of livestock manure, and family labor. The agave producers who do not have a *palenque* become associates in different mediation schemes with owners of *palenques*, remunerating them in kind. The artisanal mezcal production process includes five processes, although each mezcal master imprints a characteristic touch in each of them and in each specific process; this can generate value adding processes and, in the long term, additional income for producing families. Artisanal mezcal represents local ancestral knowledge, an attribute that requires being adequately transmitted to the consumer, as part of a local development strategy. The producers make use of diverse productive strategies to keep the tradition of artisanal mezcal alive, and to subsist in the presence of globalized competition from the industry. In face of this, the agave-mezcal chain requires an integral, permanent and wide-reaching public policy; conservation of genetic material, agronomic research, technology transference, and administrative and commercial advice and training for the market, as a way of addressing social backwardness, which mezcal production and producing zones face.

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