v. 3, n. 16, 2023

Journal of Agricultural Sciences Research

COMPREHENSIVE USE OF AGAVE SALMIANA

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Abstract: *Agave salmiana* as a maguey for the production of pulque in colonial times, represented a highly relevant source of income in Mexico, especially in the central region, however, due to the instability of its physical and chemical properties, the conservation and cultivation of this plant has been negatively impacted, which has caused an ecological impact increasing soil erosion. Despite this, some studies have shown that bioactive compounds such as saponins, agavins, antioxidants, among others, have multiple benefits for the health of the consumer, which represents an alternative for the use of the different sections of the agave such as leaves, stems, stems, flowers and mead that has aroused the interest of the government and the population to intensify the cultivation of agaves. Some trends are the application of state-of-the-art technologies for efficient performance and obtaining other components with potential use as functional ingredients in the food and even pharmaceutical industry.
Keywords: Maguey, Agave, Pulque, Gualumbos, Aguamiel
Area: Food Science

INTRODUCTION

Mexico has natural, cultural and social resources, present throughout the national territory thanks to the inclusion of these resources in economic activities in both rural and urban areas (Torres-Flores, 2013). In more than 1% of the Mexican territory, 10% of all the biological diversity in the world can be found. Among this diversity, the Agave stands out, an endemic species, which is divided into pulquero, mezcalero and textile Agaves, with the greatest diversity being the Agave pulquero such as Americanae and Salminanae (Vázquez-García, 2018).

Since ancient times, the maguey has accompanied the inhabitants of the central mountains of what is now Mexico. Although with modernity it has lost its meaning, it symbolizes a useful resource for life, since its biological and ecological properties can be used, which vary according to the life stage of the plant, making it a very versatile plant (García et al., 2016). All sections of this plant can be used, even pests. Among the products with the highest commercial value are: aguamiel, pulque, red worm, white worm and stalks. It is considered that this plant provides everything necessary for a family dedicated to rural activities to survive. The fact that today its use is comprehensive proves that man has had extensive coexistence with it for thousands of years, resulting in extensive knowledge about the parts that can be used, as well as, at the ideal time of the production cycle. plant life (Suarez et al., 2016).

This document shows a review of the generalities of the plant, a detailed description of the industrial, gastronomic and even medicinal uses, highlighting the main scientific discoveries associated with the plant or its derivatives.

FRAMEWORK

AGAVE

Agaves are perennial plant species present in desert and semi-desert areas of Mexico provided with succulent leaves in a helical position from the base of the stem, which can be short or long; They have varied morphological characteristics depending on the species in question. They are xeric plants that have adapted to unfavorable climates, long periods of drought and high temperatures (García, 2007). In ancient times they were used as a source of carbohydrates in the northern Mexican west, as well as in the American south and east; Different segments of these plants, the stems, have been consumed for food since approximately 7,000 BC. C. However, fibrous fabric has been used

for the manufacture of household products and textiles. In Central America, agaves were an important base for the production of food products from the fermentation of beverages, sweet concentrates, vinegars, ropes, clothing, construction materials and preparations for the treatment of injuries (Zizumbo-Villarreal et al., 2009).

They are a group of representative plants of Mexico, highly valued both ecologically and economically. The genus was described for the first time by Carlos Linnaeus in 1753. They are part of the floristic composition of a plant diversity, which includes tree specimens located in mountain systems above 3500 m altitude and coastal desert scrub characteristic of areas arid and semi-arid (Vazquez-Acosta et al., 2020). A characteristic that makes these plants special is their ability to adapt to different climatic conditions, as well as lands with low nutritional quality. (Guzman-Pedraza et al., 2018).

The existence of approximately 200 species is known, of which about 150 are distributed in the Mexican Republic (García, 2007); the most representative being the Agave tequilana Weber var. blue (tequila production), Agave salmiana (mezcal, pulque and maguey worm production); cultivated in the states of Aguascalientes, Baja California Norte, Baja California Sur, Coahuila, Colima, Durango, Guanajuato, Hidalgo, Jalisco, Mexico, Michoacán, Nayarit, Oaxaca, Querétaro, Quintana Roo, San Luis Potosí, Sinaloa, Tamaulipas, Tlaxcala, Veracruz, Yucatán and Zacatecas (Castro-Díaz and Guerrero-Beltrán, 2013).

GENERALITIES OF AGAVE SALMIANA

This agave is classified in the Asparagaceae family, which are considered succulent, monocotyledonous and xerophytic plants (Gentry, 2004). The Agave genus includes nearly 200 species throughout the American continent and 159 of them are found in Mexico (Angeles et al., 2017).

During the development process of agave crops, important physiological and morphological characteristics have been obtained in A. salmianae, such as a greater arrangement of the leaves with a decrease in physical protection to the plant (Mora-López et al, 2011).

Agave salmiana Otto ex Salm, is a maguey cultivated since pre-Hispanic times in the Valley of Mexico, known as maguey, agave pulquero or wonder tree (Heredia-Solís et al. 2014). It adapts to difficult environmental conditions and a wide variety of products can be produced from it. It is a plant resistant to the prolonged droughts characteristic of the states of Hidalgo. Tlaxcala, Mexico and Puebla where the amount of rain is reduced and low temperatures are frequent in autumn and winter (Angeles et al., 2017).

Agave salmiana grows in the form of dense lax rosettes, and can measure between 2.0 to 8.0 meters in height, its diameter reaches 2.0 to 5.0 meters and it can have 30 to 70 leaves per individual. The leaves of the maguey are opaque green, light green or even yellowish green, they are toothed, erect and recurved (Angeles et al., 2017).

Gentry (2004) reports that there are four internal classifications of A. salmiana Otto ex Salm-Dyck var. angustifolia, Agave salmiana Otto ex Salm-Dyck subsp crassispina, Agave salmiana var. ferox and Agave salmiana Otto ex Salm-Dyck var. salmiana.

Among the inhabitants of Mexico in the States of Hidalgo and Tlaxcala, the pulque species of A. salmiana are commonly named maguey manso, maguey chalqueño, púa long and ayoteco (Álvarez-Duarte et al., 2018).

SOCIOECONOMIC IMPORTANCE

The relationship between the Mesoamerican settlers and the maguey dates back nearly 10,000 years to the production of various materials, allowing us to know their use, the different transformation methods and materials applied in the preservation of these plant resources (Álvarez-Duarte et al, 2018; Mora-López et al., 2011).

In 1590 the maguey was called "the tree of wonders" by José Acosta, given the number of derivatives that include food, housing, clothing, fiber, medicine, among others. The findings in Teotihuacán, State of Mexico and Tula and Tulancingo Hidalgo, demonstrate that agaves have been used mainly for the extraction of aguamiel and pulque since pre-Hispanic times (Álvarez-Duarte et al., 2018).

AGAVE SALMIANA DERIVATIVES

MEAD

To make the extraction of aguamiel possible, the agave plants must mature for approximately 8 to 10 years. Once this stage has been reached, the pineapple must be peeled or scraped in the central part, where previously The tender leaves have been removed, this way the flowering stage is avoided (Alanis-Flores et al., 2011). After this cut, the center of the maguey is scraped to leave a cavity, 20-30 cm deep, to allow the sap that exudes from the maguey pineapple to accumulate, called aguamiel. Each plant can produce between 3 and 6 liters of sap daily for a period of 3 to 6 months, giving a total of 1500 L (Romero et al., 2015). Aguamiel is transparent and sweet (Tovar-Robles et al., 2011), it can be consumed fresh, fermented or concentrated by boiling in a short period of time; so that it does not ferment (Santos-Zea et al., 2016). Peasants consume it daily as "use water" (Alanis-Flores et al., 2011).

Currently, aguamiel and pulque have shown a decrease in their demand at a commercial level, this is due to the introduction of alcoholic beverages that have a better strategy for their distribution. An example of these is beer, which currently has approximately a consumption of 54%, added to this that there is another variety of drinks with ethanol throughout the world. An alternative for using mead is the obtaining and characterization of bioactive compounds in their chemical composition, such as: short chain sugars (no more than 10 monomers) that can be a substrate for the microbiota present in the colon, in addition to Antioxidant compounds have been quantified, with food, pharmaceutical and fermentation potential (Muñiz-Márquez et al., 2013). Additionally, from this sap, honey can be made, through the concentration of sugars through direct heating, this results in an increase in shelf life and favors the generation of other compounds that may have beneficial biological activity.

PULQUE

Of all the products derived from maguey, pulque is one of the main ones. It is considered an ancestral drink, with a milky, white and viscous appearance with the characteristic smell of the plant, popularly consumed in the time of the Aztecs as a drink of religious importance; Records in Teotihuacán, State of Mexico, Tula and Tulancingo, Hidalgo show that maguey have been used for this purpose for more than 3,500 years. The area known as "Los llanos de Apan" (State of Hidalgo, Puebla, Morelos, Mexico City, Tlaxcala and State of Mexico), was considered the region with the highest production of pulque during the first half of the 19th century, with the Over time, the popularity and acceptance of pulque declined until the cultivation of maguey ceased to be a primary activity for these regions (Álvarez-Duarte et al., 2018).

Currently the production of pulque is no longer considered a source of income for

families, it is only produced due to tradition and identity of the areas, however a deep-rooted taste for the drink is still preserved and although the production of pulque is currently uncertain there is a great interest in the search for innovative alternatives for their production, using technologies to generate products that preserve the quality and added value of pulque magueyes (Álvarez-Duarte et al. 2018). According to Erlwein et al., (2013) and Ramírez-Manzano et al. (2020) pulque continues to be produced in some areas of the States of Veracruz, Puebla, Tlaxcala and Mexico City for self-consumption, local consumption and export to the United States and European countries.

MEZCAL

Drink obtained from Agave salmina, however, it can be made based on other agaves such as angustifolia and potatorum (Chávez, 2010). "Mezcal" is a name from the Nahuatl mexcalli, whose meaning is cooked agave, whose process consists of fermenting the sugars present in cooked pineapples. To date, around 50 species of the Agave genus have been identified, including A. salmiana as raw material. As with any food product, a selection of the vegetative material is necessary, to which a heat treatment, grinding and fermentation of the sugar concentrate, distillation, second distillation and maturation are applied. Mexico has the designation of origin of mezcal in some municipalities of the states of Durango, Guanajuato, Guerrero, Oaxaca, San Luis Potosí, Tamaulipas, Zacatecas and Michoacán, and it is a drink with a rise in the international market with promising statistics (Pérez et al. al., 2016).

The mezcal manufacturing method considers stages such as raw material selection, heat treatment, crushing, juice fermentation, distillation and maturation. It is important to consider that when producing this type of alcoholic beverage, spontaneous reactions can occur, which can reduce the final quality of the product, due to the presence of microorganisms such as Saccharomyces, Schizosaccharomyces, Torulaspora, Kluyveromyces and Hanseniaspora; Likewise, different bacterial groups have been identified that consume medium and low molecular weight carbohydrates as a carbon source; However, during this process, non-ideal compounds can be generated during fermentation and the organoleptic quality of the drink (Nolasco et al., 2018; Ficagna et al., 2020).

MAGUEY MUSHROOMS

A saprophytic fungus known as "menanacatl" (metl = maguey, nanacatl = fungus) often grows on the maguey pulquero during the summer with increased humidity and heat (González et al. 2011), popularly called "maguey fungus." These are delicacies valued for their highly desirable flavor and aroma, consumed during the rainy seasons in areas of the Mexican highlands, State of Mexico, Jalisco, Puebla, Hidalgo, Tlaxcala, Veracruz and Oaxaca. In Figure 2 you can see a fungus emerging from the decomposing leaves of a maguey pulquero from the community of "El Tigre" in Tezoyo, State of Hidalgo. Mushrooms are usually found on live maguey trees emerging from the dry leaves at the base of the plant. The fruiting body of the maguey mushroom is characterized by having a flat convex crown, with a color that ranges from cream to yellow or dark yellow, it has a straight margin that is rarely eccentrically rolled, cylindrical and claviform, hairy at the base, whitish or yellowish., its spores have a size ranging from 8-12 x 3.5 -5 µm, smooth, thin-walled hyaline, basidia of 19-20 x 5-6 µm tetrasporic, claviform to cylindrical (Barrales and Mata, 2016; Portilla-Segura et al., 2019).

The fungi that develop on plants of the

genera Opuntia, Yucca, Agave and Phytolacca are generally associated with Pleurotus opuntiae; however, various genetic studies have shown that the fungi that grow on these plants do not correspond only to this species, but to a wide range of species. variety that includes the fungi Pleurotus djamor, Pleurotus flabellatus, Pleurotus opuntiae, Pleurotus ostreatoroseus, P. parsonsiae, Pleurotus salmoneostramineus, Pleurotus dryinus (González et al., 2011; Zervakis et al., 2019).

Traditionally, maguey mushrooms have been used as food and a remedy for various health problems, as well as for the production of alcoholic beverages from agave, in various rural areas where they are called palo ears, Patancan ears, or Cazahuate ears (Keles et al., 2011; Camacho et al., 2012). In the Mixtec region of Mexico, the consumption of mushrooms is common and to refer to Pleurotus sp., jí'i is used followed by the term yaú "maguey" resulting in jí'i yaú "maguey mushroom"; which are collected manually and transported in tenates (traditional baskets made from palm) to be sold in traditional markets, where this practice is considered a respectable tradition. In the Mixtec region it is possible to find mushrooms during July and September for culinary preparations as an accompaniment to traditional mole; or for other practices such as microtherapy, where the steam from boiling mushrooms is used for vaporizations that are believed to eliminate skin spots (Aparicio, 2019).

Because the maguey mushroom grows in the rainy season and exclusively on maguey trees, it is difficult to market it on a large scale; Some researchers have shown interest in evaluating the cultivation potential of the species on different substrates; Heredia-Solis (2014), Chairez-Aquino et al. (2015) ventured into the use of agave bagasse for the cultivation of P. ostreatus, while Barrales and Mata, (2016) began the cultivation of P. opuntiae on commercial substrates (barley straw and cane leaf) with favorable results; Spain - Rodríguez et al., (2021), cultivated a fungus isolated from a maguey stalk from the municipality of Chilcuautla, State of Hidalgo on Agave salmiana bagasse to compare its biological efficiency (BE) and nutritional composition with respect to cultivated Pleurotus ostreatus in barley straw (substrate and conventional fungus cultivated on a large scale), obtaining for the maguey fungus cultivated in agave bagasse an EB of 52.3%, which is why these authors propose maguey bagasse as a substrate with the potential to be used commercially. Regarding their nutritional composition, mushrooms are appreciated for their high protein content, in their study Spain - Rodríguez et al. (2021) reported that the maguey mushroom has 24% crude protein, while P. ostreatus only contained 18% protein. In a more recent work, Velázquez - De Lucio et al., (2022) concluded in their study that a maguey fungus isolated from a maguey stalk belongs to Pleurotus djamor and can be intensively cultivated on Agave salmiana bagasse supplemented with urea and achieve an EB of up to 70%, which represents an important opportunity to market the maguey mushroom that is only used in rainy seasons. In addition, the mushroom used in this study has between 15 and 26% crude protein depending on the growing conditions.

FLOWERS (QUIOTES OR GUALUMBOS)

The mature flowers that emerge from agaves are known as gualumbos and have been consumed since ancient times for their culinary delicacy; They are currently sold in local markets in Hidalgo and other States to be enjoyed alone or accompanied, in stews or salads (Urbina, 2020), cooked over firewood in barbecue-style pits, as sweets (Alanis-Flores and Gonzalez - Álvarez, 2011), etc; Specifically

in the State of Hidalgo, the gualumbos that are consumed belong to the species Agave salmiana (Urbina, 2020).

In addition to their unmatched flavor, the gualumbos consumed in Mexico are rich in functional compounds such as carotenoids and anthocyanins responsible for the characteristic yellow color, compounds such as xanthophyll or lutein, precursors of vitamin A. Gualumbos also contain minerals such as calcium, phosphorus, iron and potassium. The flowers of A. salmiana have high contents of water, fiber, amino acids and steroidal saponins responsible for the characteristic bitter flavor; however, these are hydrolyzed by heat. Likewise, high levels of protein have been found (Sotelo et al., 2007; Figueredo et al., 2019).

PENCAS

An important segment of the maguey plant, of commercial interest, is its leaves, which constitute up to 50% of the total agave; Due to its use as an ingredient for different dishes of Mexican gastronomy, a generation of waste of up to more than 5,000 tons has been reported in the period from 2015 to 2019. Chemically, the leaves contain soluble and insoluble fibers that in turn contain lignin, cellulose and hemicelluloses, depending on the relationship that exists between these compounds, the leaves can be a source of textile or edible products. A particular characteristic of the salmiana species is that threads can be obtained traditionally for the manufacture of ties. However, the field of science has taken on the task of proposing alternatives for using these plant residues for their incorporation as raw materials for biodegradable plastics where excellent properties have been reported when applying heat and effort, while the leaves can also be used. provide considerable quantities of bioethanol, other bioactive compounds reported in the literature are saponins, fructans and phenolic compounds (Láinez et al., 2019), likewise, dried and ground leaves have been used as a substrate in the cultivation of edible fungi such as mushrooms (Velázquez - De Lucio et al., 2022).

CHINICUIL

Comadia redtenbacheri, commonly known as chinicuil, or red maguey worm in its larval state, this insect makes its gallery inside the stem of the agaves where it completes its life cycle (Molina-Vega et al., 2021). It is considered an important insect from a nutritional and economic point of view, distributing from the southeast of Texas, USA, to Mexico, where it is widely distributed in the states of Guanajuato, Hidalgo, Mexico, Michoacán, Oaxaca, Puebla, Querétaro, Tlaxcala, Zacatecas, Veracruz and Mexico City (Jimenez-Vazquez et al., 2022).

The collection of these insects is stationary, so they cannot be obtained all year round, this causes their price to be high, reaching up to 24.13 USD per liter. Among the uses of chinicuil, its addition to bottles to give appearance and added value stands out, and the gastronomic uses, they are cooked fried with butter or in sauces, it is important to highlight that in rural areas they are consumed not as an exotic dish, but rather as a regular food and generally the cooking method is dehydrated (Ariza-Ortega et al., 2020; Escamilla-Rosales et al., 2021).

TRENDS AND INNOVATION IN BIOACTIVE COMPOUNDS

The most recent research has focused on the study of the functional and nutraceutical properties of both the plant and its byproducts, highlighting the extraction, purification, identification and quantification of phenolic compounds, saponins and fructooligosaccharides, among others, testing their effects against conditions such as diabetes, hypertension, and even cancer.

These works focus on the improvement of production methods, up to the application of said compounds in laboratory models and in experimental animals.

Reynoso et al. (2017) mention that combining methods for purification of fructans present in Agave salmiana, such as nanofiltration (NF) and spray drying, allows the elimination of low molecular weight sugars and, therefore, increases the amount of fructans from Agave juice. A study carried out applying NF in a stirred cell unit and a hydrophilic cellulose membrane with MWCO of 1000 Da, under concentration and diafiltration conditions and a volume reduction factor (VRF) = 2.7, 4 and dilution factor volume (VDF)=1, 2.7 and 4, respectively. The equipment used was a dryer with a B-290 mini atomizer at inlet temperatures between 160 and 180°C, considering a central rotating compound design with five central points and powder yield (PY), moisture content (MC), value Purity (PV) and glass transition temperature (Tg) were measured as dependent variables. Response surface plots ($p<0.05$) showed that the highest PY value and fructans with the highest purity were obtained when combining NF was with VDF of 4 and spray drying at 170°C. For MC, inlet temperature and dilution factor were the most important factors. However, there was no significant effect on Tg, and an average value of 131.4±4.3°C was found for anhydrous Agave salmiana fructans with a PV that ranged between 87.3 and 99.2%. These methodologies become fructan purification techniques, which are important at a commercial level due to their functional properties on consumer health and their technological applications as food ingredients.

Some important properties attributed to saponins are the reduction of cancer cell growth and apoptosis, this effect evaluated in agave honey. Traditionally, in Mexican food, it has been empirically demonstrated that the fermentation that occurs after concentrating the agave sap is due to the microorganisms that survive after cooking, and to the effect on saponins and other secondary metabolites. In an evaluation of the changes in the metabolites found in the sap of agave (A. salmiana) after its fermentation due to the presence of microorganisms isolated from it, we wanted to determine its anticancer activity. Microorganisms were isolated by dilution plating and identified by 16S rRNA analysis. The fermentation process was through the inoculation of these microorganisms, as well as, butanolic extracts were carried out to develop the comparison in the improvement of cytotoxic properties in cellular models of colonic carcinoma (Caco-2) and liver (Hep-G2). Metabolite changes were determined by mass spectrometry-based metabolomics. There were a total of 69 isolated microorganisms, the actinomycetes Arthrobacter globiformis and Gordonia sp. were used to analyze metabolites, along with bioactivity changes. Of the 939 ions that were mainly responsible for the differences between the samples fermented at 48, 96 and 192 h, four were correlated to anticancer activity. Demonstrating that magueyoside B, a kammogenin glycoside, was found in greater quantity in samples fermented with Gordonia sp. The viability of Hep-G2 considerably decreased vs. controls. These findings showed that the microorganisms in the agave sap concentrate undergo changes. While butanolic extracts, obtained after fermentation of agave sap with Arthrobacter globiformis or Gordonia sp., increased the inhibitory effect on the growth of colon cancer cells and liver cancer cells, respectively (Figueroa et al., 2017).

When the pulquero agave is used, residues called bagasse are obtained, a material that is considered waste both in the production

of regional products and in the process of extraction of aguamiel for the production of pulque. However, this residue is a potential source of raw material for bioactive compounds such as steroidal saponins and some other phytochemicals. A methodology to improve the extraction of this type of plant components is ultrasonic-assisted extraction (UAE), which, through the use of solvents such as water and ethanol, allows greater efficiency in terms of the yield of compounds. The effect of the chemical composition of the solvents and the intensity of the ultrasonic field during UAE on the saponin content from agave residues evaluated by Santos et al. (2020) showed that the optimal extraction variables were at a temperature of 60 °C and a solvent/mass ratio of 20 (S/M) to UAE under conventional conditions. The amount of saponins obtained without ultrasound in 58% ethanol was 22.48 ± 1.34 mg PE/g dry weight, which turned out to be similar to the amount obtained by EAU in water (24.41 ± 0.84 mg PE/g dry weight). When using only water, the ultrasound intensity allowed extraction of 271.40 ± 11.91 M/L compared to ethanol mixtures (144.81–202.30 W/L) due to the intensity of cavitation, demonstrated in a paper test aluminum and SEM images of bagasse. Therefore, the application of UAE using water as a solvent is an excellent alternative to recover bioactive compounds from agave bagasse.

Some important findings are the relationship between the consumption of agavins and its effect on the increase in interleukin IL-10 (Huazan et al., 2017), as well as the regulation of the production of Foxp3, which serves as a control mechanism. of IL-10 production by Treg. Moreno et al., (2014), evaluated the positive regulation of Foxp3 induced by agavins (AG) obtained from Agave salmiana in nuclear cell laboratory conditions in healthy subjects. Likewise, the growth of M. intestinale and B. uniformis in mice fed GA was also associated with anti-inflammatory activity by stimulating the secretion of IL-10. This is due to the fact that there is a positive trend of Foxp3 due to the degradation of dietary fiber and long-chain oligosaccharides by the intestinal microbiota. Another study that supports these effects is the increase in glycan-degrading bacterial taxa by Bacteroidota and a proportion of butyrate secreted in obese mice treated with agavins. Demonstrating that this butyrate participates in the generation and function of colonic Treg by increasing the expression of the transcription factor Foxp3.

FUNCTIONAL PROPERTIES

The fructooligosaccharides (FOS) present in the agave and whose chemical structure prevents its hydrolysis during the digestion process for its assimilation as glucose or fructose, which gives it characteristics that make it an ideal substrate for the microbiota present in the colon, favoring both the growth of the microbial population as well as maintaining the health of colonic cells. Another good example of these FOS is inulin, present in agave leaves and which, when consumed by colonic microorganisms, produces short chain fatty acids (SCFAs). Other properties or effects on the health of those who consume them have also been attributed to these components, some reported being a decrease in serum levels of both glucose and lipids, improvement in the absorption of minerals, as well as stimulation of movements. intestinal. However, in the food area, FOS have been used as wall materials for encapsulation of functional ingredients (Escobedo et al., 2020).

In the particular case of microorganism inhibition activity, this has been associated with the content of phenols and saponins that have an effect on the cell membrane, specifically due to the interaction it has with

proteins and lipids, due to changes in the charges that modulate permeability, thus promoting the loss of cellular components in Gram-positive and Gram-negative microorganisms, and against pathogens such as E. coli, Salmonella, Staphylococcus aureus and Listeria monocytogenes. Another influence that extracts obtained from agave have is the antifungal activity attributed to terpenes (López et al., 2018).

An important quality of agave is that it also has flavonols, highlighting kaempferol and quercetin, which, like phenolic compounds, have antioxidant activity. These antioxidants are found in a greater proportion in leaves and pineapple, segments where pyranones and pyrazines have also been identified. The tests applied to determine the antioxidant activity have been under in vitro conditions. However, properties of great impact on the health of consumers due to the presence of molecules is the interruption of the inflammatory process as a synergistic effect with saponins, phenolic compounds and terpenes. The power of these types of properties has been associated with promising results in anticancer and antihypertensive activity. Which opens a field of opportunities to study in depth the different effects in humans in order to determine safe doses that do not involve side effects, because there is scientific support (Santos et al., 2019).

CONCLUSION

According to the information reported to date, the comprehensive use of the maguey pulquero to improve the economic conditions of the central zone and the country, contributing significantly to the development of the most marginalized communities by encouraging the cultivation of this plant. At the same time, it is an opportunity to generate companies that are dedicated to agribusiness activities, developing new products at the artisanal, semi-industrial and industrial level with promising economic gains. Therefore, business and scientific research can be promoted with a social, economic and especially sustainable development impact. Likewise, a diversity of products would be implemented that would have in their formulation both leaves, stems, flowers, mead and bioactive compounds as functional ingredients with health benefits.

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