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Journal of Enviromental Sciences and Natural Resources

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Knowledge Area

The works must be unpublished and refer to topics of agriculture-forest, pathology-sustainable, horticulture, fisheries and aquaculture, agricultural biotechnology and other topics related to Biotechnology and Agricultural Sciences.

Presentation of content

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Comparative analysis of average temperature trends in Jalisco, Mexico, based on original and homogenized series to estimate signs of Climate Change

Análisis comparativo de tendencias de temperatura media en Jalisco, México, basado en series originales y homogeneizadas para estimar señales de Cambio Climático

DAVYDOVA-BELITSKAYA, Valentina†, GODÍNEZ-CARVENTE, Andrea Liliana, NAVARRO-RODRÍGUEZ, René and OROZCO-MEDINA, Martha Georgina*

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Abstract

In recent decades, great attempts have been made to create high-quality climatic data sets and spatial resolution on a continental and national scale, as well as the analysis of their variability and change in daily extremes. However, in Mexico there is still no high-resolution database at a national level that complies with quality control, including the review of homogeneity of long series. This paper shows the results of variability analysis and the detection of climate change signs in the state of Jalisco, performed in a high-resolution database developed for the maximum, minimum and average temperature according to the quality control procedures of climatic records. From these two sets, the spatial behavior of annual average temperature estimated for three climatic periods was analyzed. Among the results obtained with stations which have complied with quality control, the presence of annual average temperature increases at 0.31°C in 1971-2000, 0.61°C in 1981-2010 and a very intense increase, 0.81°C for the period 1991-2010. Likewise, it was observed that the Jalisco coasts show an increase of 0.2 to 0.4°C, while the continental region registers an increase up to 0.8°C.

temperature, Quality control, Climate trends, Jalisco

Resumen

En las últimas décadas se dedicó un gran esfuerzo a la creación de conjuntos de datos climáticos de alta calidad y resolución espacial a escala continental y nacional, también al análisis de su variabilidad y cambio en extremos diarios. En México todavía no existe una base de datos de alta resolución a escala nacional que cumpla con un control de calidad incluyendo la revisión de homogeneidad de series largas. En el presente trabajo se muestran los resultados de análisis de variabilidad y la detección de señales de cambio climático en el estado de Jalisco realizado en una base de datos de alta resolución desarrollada para la temperatura máxima, mínima y media de acuerdo a los procedimientos de control de calidad de registros climáticos. A partir de éstos dos conjuntos se analiza el comportamiento espacial de temperatura media anual estimada para tres períodos climáticos. Destaca la presencia de incrementos de temperatura media anual a 0.31°C en 1971-2000, 0.61°C en 1981-2010 y un incremento muy intenso, 0.81°C, para el período de 1991-2010. Asimismo, se observa que las costas de Jalisco muestran un incremento de 0.2 a 0.4°C mientras la región continental registra un incremento hasta 0.8°C.

Temperatura, Control de calidad, Tendencias climáticas, Jalisco

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1. Introduction

Over the past 30 years, considerable attention was focused on trend analysis in long series of air temperature, focusing on the development of high-quality data sets in order to obtain the highest spatial resolution information for the longest possible periods. Thanks to these efforts, three main databases are available today on a global scale (González-Hidalgo, et al., 2015; Jones & Wigley, 2010): from the Global Historical Climatology Network (GHCN) updated by (Lawrimore, et al., 2011), of the Goddard Institute for Space Studies (GISS) updated by (Hansen, et al., 2010) and the Climate Research Unit, affiliated to the Hadley Center of the Meteorological Office of Great Britain (HadCRUTEM4) updated by (Jones, et al., 2012).

These databases share the same original data and differ in the quality control technique that was applied to them (Feng, et al., 2004; Jones & Wigley, 2010; González-Hidalgo, et al., 2015). Using these updated databases, the Intergovernmental Panel on Climate Change (IPCC, 2013) summarized the global warming processes observed from 1880 to 2010, confirming the results of previous research published in the original research papers (Jones & Moberg, 2003), as well as in the IPCC reports (IPCC, 2007; PICC, 2001). Another great effort has been devoted to the creation of high spatial resolution climatic databases at continental, regional and national levels, as well as to the analysis of their spatial variability and change in daily extremes (Guttman, 1996; NOAA, 1996; Balling Jr. & Idso, 2002; Feng, et al., 2004; Feidas, et al., 2004; Aguilar, et al., 2005; Brunetti, et al., 2006; Brunet, et al., 2006; Brunet, et al., 2007).

In Mexico, the National Institute of Ecology and Climate Change (INECC, in its Spanish acronym) through collaboration with the international group of Experts on Climate Change Detection and Indexes (ETCCDI) and with the purpose of advancing monitoring national climate, it promoted the project “Strengthening of Capacities in Climate Change Detection in Mexico,” sponsored by the Fund of Strategic Programs of the United Kingdom and coordinated at the Universidad Iberoamericana Puebla, and conducted the training course called “Workshop on Detection and Indices of Climate Change in the Mexican Republic” carried out in May 2009.

In this workshop, participants tried to calculate the climate change indices based on the maximum, minimum temperature and precipitation climate information provided by the National Meteorological Service, National Water Commission (Vázquez-Aguirre, 2010).

However, in Mexico there is no high-resolution database (daily climate information) that meets the necessary quality controls aimed at cementing studies of climate variability and trends at national, state and local levels. Therefore, this work shows the results of developing a high-resolution database for the maximum, average and minimum temperature. A comparative analysis of the estimated annual average temperature trends for the periods 1961–1990, 1971–2000 and 1981–2010 in the state of Jalisco is also carried out, based on quality control and the homogeneity review of the long series according to the recommendations of the World Meteorological Organization (WMO, 2010; WMO, 2011; WMO, 2016; WMO, 2017).

It is important to highlight that despite great progress in the development of high-resolution databases at global and regional level, academics continue to review and improve homogenization techniques to optimize the detection of inhomogeneity in climatic data due to man-induced factors, as well as to continue with the rescue of historical climate records (Beaulieu et al., 2008; Domonkos, 2011; Domonkos, 2013; Acquaotta & Fratianni, 2014; Ribeiroa et al., 2015; Killick, 2016; Gubler et al., 2017; Domonkos & Coll, 2017; Termonia et al., 2018).

2. Data and Methodology

2.1. Study Area

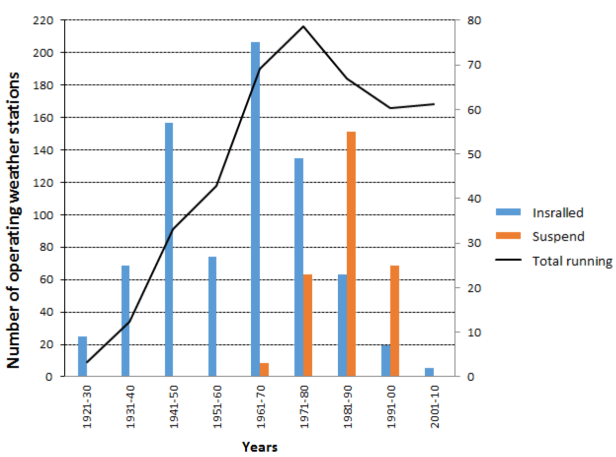
The state of Jalisco is in the middle western region of the country, between the following coordinates: 22º 45’ north and 18º 55’ south latitude, east longitude 101º 28’ and west 105º 42’. It has a territorial extension of 77965.88 km² which represents 4% of the national surface. It borders the state of Nayarit to the northwest; Zacatecas and Aguascalientes to the north; Guanajuato and San Luis Potosí to the east; Colima and Michoacán to the south; and towards the west, a coastal strip of 351 km with the Pacific Ocean.

The landscape of Jalisco is characterized by the predominance of mountains, high plateaus and the total absence of extensive plains (INEGI, 2014).

2.2. Data and its source

In order to carry out the study of variability and detect possible signs of climate change in the state of Jalisco, the information of the 274 weather stations in the state of Jalisco was used. As of January 1989, these have been administered by the Management of Surface Water and River Engineering (GASIR, in its Spanish acronym), which is part of the Technical Sub-Directorate of the National Water Commission (CONAGUA, in its Spanish acronym).

However, historical information files that have a daily record of precipitation, as well as maximum and minimum temperatures are under the management of the National Meteorological Service (SMN, in its Spanish acronym). Graph 1 shows the progress of the network of traditional weather stations during the period 1920-2010.



Graph 1 Progress in the development of the network of traditional weather stations in the period from 1921 to 2010. Navarro, 2015
Sources: Based on data from the National Meteorological System of the National Water Commission SMN/CNA

However, the analysis of data density, that is, that each series has at least 80% information, the original set was reduced to a total of 89 stations, 13 of which were suspended in the 1990's. In other words, only 28% of the initial information or 76 stations underwent quality control process.

2.3. Quality Control Analysis

This analysis is extremely important for the calculation of climate change indices, since any erroneous data can have impacts on trends in temperature or precipitation variations. These processes are applied to detect and identify errors which occur during the acquisition, manipulation, format, transmission and filing of data (Aguilar et al., 2003).

An initial monitoring was carried out in the original monthly series, searching for suspicious and inconsistent data, and applying the following criteria:

- $t_{max} < t_{min}$
- Absolute value of t_{max} above 50°C and below -25°C
- Maximum monthly range is greater than 50°C

The RClimdex program implemented in R language and developed by Byron Gleason of the National Climate Data Center (NCDC) of NOAA (National Oceanic and Atmospheric Administration) was applied to analyze the quality of climate data and has been used in multiple workshops on climate indices since 2001 (Zhang & Yang, 2004). In order not to lose records for extreme and atypical events, a threshold of four standard deviations was chosen at the time of running the program.

In addition, temporal and spatial coherence tests were performed (Vincent et al., 2002; 2005; 2012; Wang et al. 2013; Xu et al., 2013). Temporal coherence consists in verifying that the observed variability from one register to the next is within a characteristic limit for the station, i.e., if there was an extreme event or if the information is not justified. The spatial coherence analysis was performed in order to verify whether the behavior of the observations was consistent with those reported at the same time by other stations in similar conditions in a given spatial neighborhood.

The comparative temperature analysis of the stations was then carried out considering that they were complying with a similar altitude pattern using the Digital Elevation Model (INEGI, 2013) and that they were at a relatively short distance from each other, 50 kilometers maximum.

This is to ensure that the conditions under which the data was compared are as similar to each other as possible and that the data is attributed only to variations in local climatic processes.

Metadata are important in the process of quality control of climate series and in the evaluation of the homogeneity of time series. If sufficient metadata is available, it is easier to determine whether a discontinuity may be caused due to factors outside natural climatic variability, which were already mentioned previously (Aguilar, et al., 2003; Feng, et al., 2004; Vázquez Aguirre, 2010). To develop the metadata files of preselected stations, field research was carried out with Leica GEB121 equipment. It is easy to observe that most stations show a bias regarding their documented positioning in the archives of the National Meteorological Service, National Water Commission (Figure 1).

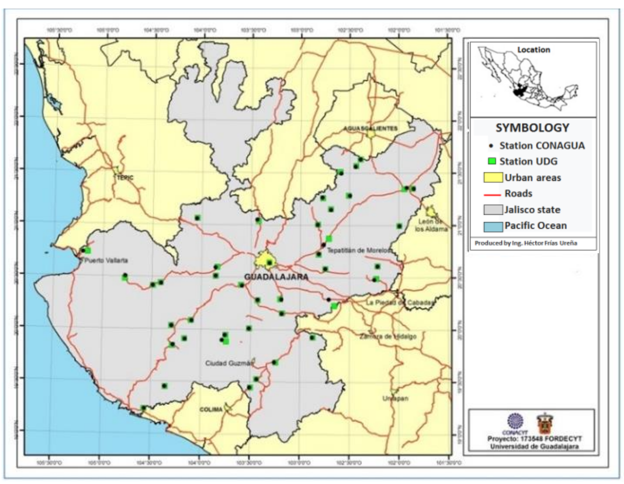


Figure 1 Update of the positioning of the CONAGUA weather stations in the state of Jalisco for the quality control process
Source: Davydova-Belitskaya, 2013

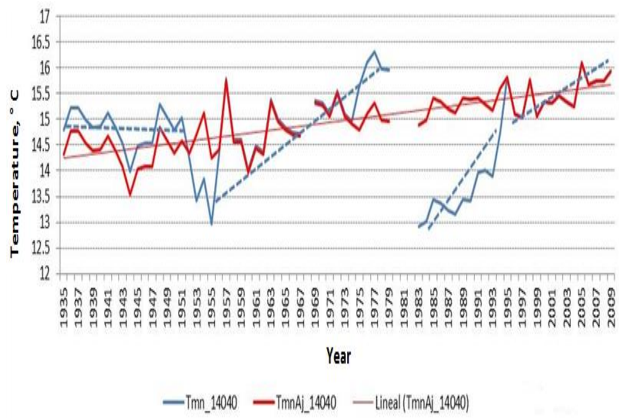
2.4. Homogeneity analysis

The homogeneity of climate data over time directly affects the possibility of calculating and analyzing trends (IPCC, 2007; WMO, 2009).

The tests to demonstrate that a time series of a climatic variable is reasonably homogeneous are intended to ensure that the variations contained in the observations correspond only to climatic processes (WMO, 2009; Wang and Feng, 2013)

For this investigation, we used the methodology of Wang and Feng (2013) based on a two-phase regression model, which applies F and t test functions with penalty (PMT and PMF), capable of detecting displacements in the mean time series of zero tendency, using an empirically constructed penalty function to match the profile of the false alarm rate.

The homogenization of long series of monthly maximum and minimum temperatures in the stations that have complied with the quality control process was executed using the RHtest V4 software. Graph 2 shows the cases of heterogeneous series and after the homogenization process.



Graph 2 The behavior of the original annual average minimum temperature series at station 14040 is shown as a function of time (blue line) and its distribution after the homogenization process (red line)
Source: Navarro, 2015

3. Results

From the quality control and homogenization processes of long series, as well as the available metadata, 22 of the 89 preselected stations were chosen (Fig. 2). It is important to stress that some stations with long series and records since the 1940's were discarded because of the absence of minimum or maximum temperature records, or both in the months of January and December, particularly from the 1990's, that is, during the last two decades.

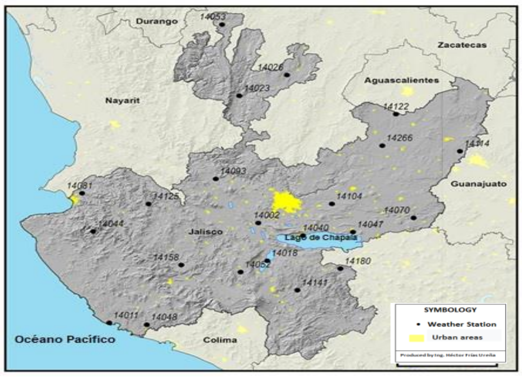


Figure 2 Spatial distribution of the stations that met the quality control and homogenization processes, Jalisco, México
Source: Prepared by the authors

Note that the spatial behavior of the selected stations is balanced, i.e., it covers almost the entire territory, except the southern region and the state's coastline.

The average monthly temperature was calculated from the monthly maximum and minimum temperature records with the arithmetic average of these. Subsequently, the average annual temperature values were estimated for three representative climatic periods, 1961-1990, 1971-2000 and 1981-2010, as well as the average annual temperature for the period 1991-2010 (Table 1).

Code	Name	Municipality	Latitud (N)	Longitude (W)	$t_{med(61-90)}$, °C	$t_{med(71-00)}$, °C	$t_{med(81-10)}$, °C	$t_{med(91-10)}$, °C
14002	Acatlán de Juárez	Acatlán de Juárez	20°25'34	103°35'52"	19.57	20.1	20.57	20.62
14011	Apazulco	La Huerta	19°18'23	104°53'15"	24.5	24.73	24.86	25.01
14018	Atoyac	Atoyac	20°0'37	103°30'55"	20.79	21.1	21.44	21.79
14023	Bolaños	Bolaños	21°49'30	103°47'00"	24.36	24.52	24.62	24.91
14026	Casa Llanta	Colotlán	22°03'32	103°21'43"	17	17.4	17.87	18.18
14040	Chapala	Chapala	20°17'25	103°12'6"	20.66	20.96	21.05	21.11
14044	El Bramador	Talpa de Allende	20°18'36	105°2'59"	24.75	25.09	25.41	25.69
14047	El Fuerte	Ocotlán	20°19'51	102°45'48"	19.45	19.57	19.87	19.87
14048	El Chiflón	Cihuatlán	19°17'30	104°33'10"	24.69	25.11	25.74	25.88
14052	El Nogal	Tapalpa	19°52'59	103°44'49"	15.13	15.41	15.87	16.05
14053	El Pinito	Huejuquilla e Alto	22°36°3	103°56'54"	17.11	17.82	18.37	18.71
14070	Huascato	Degollado	20°29'23	102°13'51"	17.92	18.11	18.4	18.48
14081	La Desembocada	Puerto Vallar	20°43'40	105°9'26"	25.53	25.7	25.97	26.24
14093	Magdalena	Magdalena	20°54'23	103°58'47"	20.28	20.28	20.88	21.05
14104	Palo Verde	Zapotlanejo	20°38'25	102°57'04"	17.89	18.5	18.95	19.13
14114	Presa La Duquesa	Lagos de Moreno	21°13'28	101°49'12"	17.34	17.81	18.26	18.44
14122	San Bernando	Teocaltiche	21°37'54	102°23'22"	17.39	17.75	17.98	18.13
14125	San Gregorio	Gómez Faría	20°37'15	104°34'05"	15.26	15.51	15.78	15.8
14141	Ingenio	Tamazula de Gordiano	19°41'13	103°14'43"	21.2	21.41	21.7	21.85
14158	Unión de Tula	Unión de Tul	19°57'16	104°16'04"	20.42	20.61	20.76	20.83
14180	Quitupan	Quitupan	19°55'38	102°52'16"	19.79	20.11	20.33	20.41
14266	San Gaspar de los Reyes	Jalostotitlán	21°17'05	102°30'35"	16.75	16.94	17.3	17.46

Table 1 Estimated average annual temperature for the periods 1971-2000, 1981-2010 and 1991-2010
Source: Prepared by the authors based on data from SMN/CNA.

To estimate the temperature change in the last decades in Jalisco, values of $\Delta t_{md71-00}$, $\Delta t_{md81-10}$ and $\Delta t_{md91-10}$ are calculated considering the reference 1961-1990 climate period (Table 2). It is important to emphasize that in all the stations, in the three analysis periods, there was a positive change or increase in average annual temperature.

Code	Name	Municipality	Latitude (N)	Longitude (W)	Altitude	Δt_{md} 71-00	Δt_{md} 81-10	Δt_{md} 91-10
14002	Acatlán de Juárez	Acatlán de Juárez	20°25'34"	103°35'52"	1344.51	0.53	1	1.05
14011	Apazulco	La Huerta	19°18'23"	104°53'15"	5	0.23	0.36	0.52
14018	Atoyac	Atoyac	20°0'37"	103°30'55"	1341.26	0.31	0.65	1
14023	Bolaños	Bolaños	21°49'30"	103°47'00"	963	0.16	0.26	0.56
14026	Casa Llanta	Colotlán	22°03'32"	103°21'43"	1730	0.4	0.86	1.17
14040	Chapala	Chapala	20°17'25"	103°12'6"	1510.26	0.3	0.39	0.45
14044	El Bramador	Talpa de Allende	20°18'36"	105°2'59"	1704	0.34	0.66	0.94
14047	El Fuerte	Ocotlán	20°19'51"	102°45'48"	1540	0.12	0.42	0.41
14048	El Chiflón	Cihuatlán	19°17'30"	104°33'10"	360	0.42	1.05	1.19
14052	El Nogal	Tapalpa	19°52'59"	103°44'49"	1963.29	0.28	0.73	0.92
14053	El Pinito	Huejuquilla el Alto	22°36°33'	103°56'54"	1684	0.71	0.55	1.6
14070	Huascato	Degollado	20°29'23"	102°13'51"	1658.16	0.19	0.48	0.56
14081	La Desembocada	Puerto Vallarta	20°43'40"	105°9'26"	10.42	0.17	0.44	0.71
14093	Magdalena	Magdalena	20°54'23"	103°58'47"	1380	0.18	0.59	0.76
14104	Palo Verde	Zapotlanejo	20°38'25"	102°57'04"	1730	0.61	1.06	1.24
14114	Presa La Duquesa	Lagos de Moreno	21°13'28"	101°49'12"	1950	0.46	0.91	1.1
14122	San Bernando	Teocaltiche	21°37'54"	102°23'22"	1796.87	0.36	0.59	0.74
14125	San Gregorio	Gómez Farías	20°37'15"	104°34'05"	1640	0.25	0.52	0.54
14141	Ingenio	Tamazula de Gordiano	19°41'13"	103°14'43"	1450	0.21	0.5	0.64
14158	Unión de Tula	Unión de Tula	19°57'16"	104°16'04"	1340	0.19	0.34	0.41
14180	Quitupan	Quitupan	19°55'38"	102°52'16"	1593	0.32	0.53	0.61
14266	San Gaspar de los Reyes	Jalostotitlán	21°17'05"	102°30'35"	1657.35	0.19	0.55	0.71

Table 2 Estimated average annual temperature change for the periods 1971-2000, 1981-2010 and 1991-2010
Source: Prepared by the authors from data from the SMN / CNA

The spatial behavior of the average temperature trend is shown on the maps constructed with the ESRI ArcGIS 10.1 computational tool for the three periods (Fig. 3-5). It is important to mention that a higher temperature increase is observed in the temperature trend map of the homogenized data compared to the original information. However, in both cases and in all stations, positive trends are recorded, while in the periods 1981-2010 (Fig. 4 ab) and 1991-2010 (Fig. 5 ab) the estimated trend behavior with original data or without homogenization shows both negative and positive trends.

This behavior is physically unlikely and, based on metadata information, is explained by the modification of the minimum and maximum average temperatures due to the relocation of thermopluviometric stations during the 1980’s and the beginning of the 1990’s. Nonetheless, the maps with the homogenized series show a growing tendency for the period 1981-2010, as well as 1991-2010, where the last 20 years (1991-2010) show an increase of 0.81°C or 0.2°C greater than the 1981-2010 period.

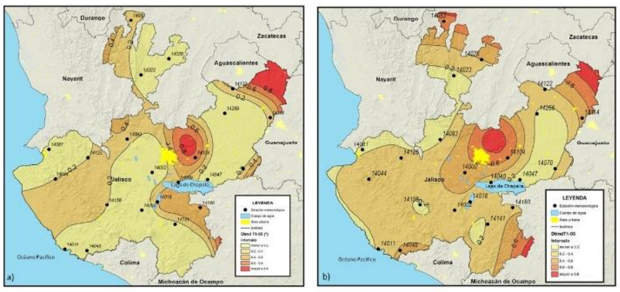


Figure 3 Spatial behavior of the estimated temperature trend for the 1971-2000 period with data from a) original series and b)homogenized series
Source: Prepared by the authors based on data from SMN/CNA

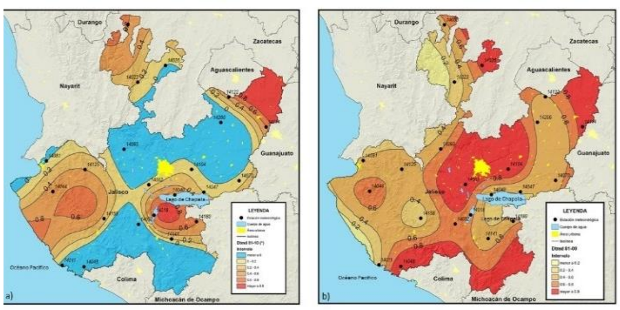


Figure 4 Spatial behavior of the estimated temperature trend for the 1981-2010 period with data from a) original series and b)homogenized series
Source: Prepared by the authors based on data from SMN/CNA

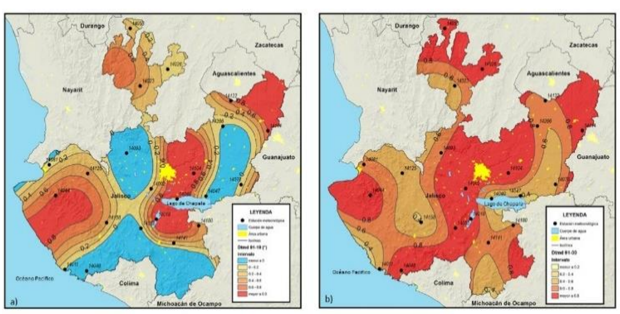


Figure 5 Spatial behavior of the estimated temperature trend for the 1991-2010 period with data from a) original series and b)homogenized series
Source: Prepared by the authors based on data from SMN/CNA

It is interesting to note that along the coast and around Lake Chapala the temperature increase is milder compared to the continental region of the state, which can be explained by the abundant presence of water vapor or high humidity levels. (Fig. 4b - 5b).

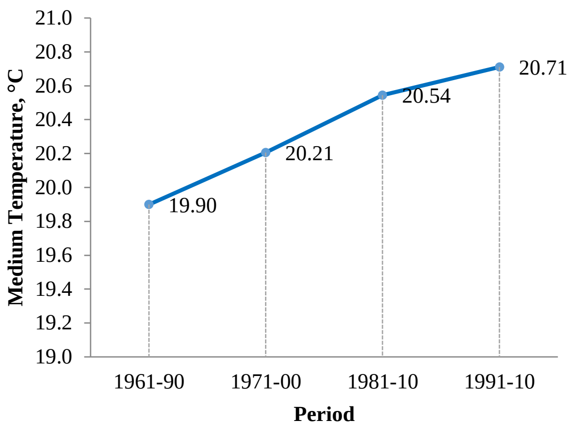
The comparison of three different periods makes it possible to locate the most vulnerable areas regarding climate change impact, particularly intense annual average temperature increase: central, south, south-west regions, as well as the east zone in the north and the Los Altos de Jalisco region.

From the information generated, the following stands out:

It is the first research work carried out for the state of Jalisco that applied a quality control of climatological series as well as its homogenization, which allowed to visualize true temperature trends, their oscillations and anomalies. It also established the development of the thesis “Study of the Variability and Trends of Climate Change in the state of Jalisco during the Period 1961-2010” (Navarro, 2015).

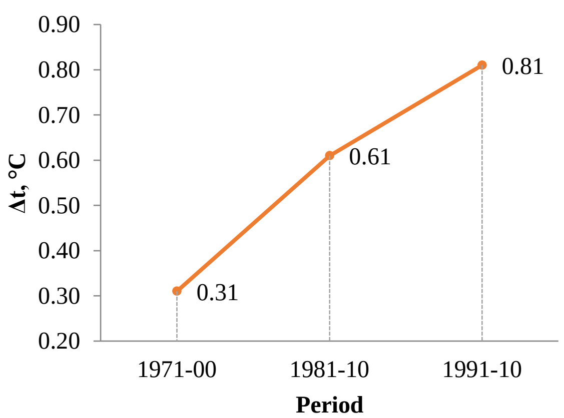
The collection, processing and management of climate data showed insufficient quality for direct use in the inferential analysis of climate variability and change in the region. Therefore, a detailed review and modification of climatological data was conducted applying the techniques and procedures established by the World Meteorological Organization (WMO, 2010, WMO, 2011, WMO, 2016).

The average of the mean temperature calculated for stations that have complied with quality control shows an increase for the three study periods (Graph 3). The growing annual average temperature trends at regional level were also recorded in recent studies from Brazil, Peru and Romania (Acquaotta & Fratianni, 2014; Dumitrescu, Bojariu, Birsan, Marin, & Manea, 2015; Gubler, and others, 2017).



Graph 3 Average annual mean temperature distribution from 1961 to 2010
Source: Prepared by the authors

The calculation of the average annual mean temperature trend shows a behavior similar to that reported for global climate change (Graph 4).



Graph 4 Temporal behavior of the average annual mean temperature increase from 1961 to 2010
Source: Prepared by the authors

4. Acknowledgments

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5. Conclusions

In summary, signs of climate change are observed from the analysis carried out in the state of Jalisco.

In addition, the magnitude of this change is greater than the one showed by some previous studies performed and published by the Secretary of the Environment and Territorial Development of the state of Jalisco (Autonomous University of Guadalajara, 2014), so it is recommended to update these studies observing the quality control guidelines of climatic data, particularly the development of metadata files and homogenization of its long series.

The comparative analysis in this study demonstrates the importance of continuing quality control of climatic data, including the homogenization of long series, a process that will allow to eliminate the variations induced by human activity: relocation of station, change of observation equipment, emergent constructions near climatic stations, etc.

By excluding non-climatic factors, a positive trend of the estimated annual average temperature for three climatic periods was detected: 1971-2000, 1981-2010 and 1991-2010. It is important to mention that the growing trend of the average annual temperature is lower along the coast of the state of Jalisco and in the Lake Chapala basin, while the most vulnerable areas to intense increase in average annual temperature are the center, south, and south-west regions, as well as the east zone in the north and the Los Altos de Jalisco region.

6. References

Acquaotta, F., & Fratianni, S. (2014). The importance of the quality and reliability of the historical time series for the study of climate change. *Revista Brasileira de Climatologia, 10*(14), 20- 38. Retrieved from: https://iris.unito.it/retrieve/handle/2318/153713/27203/38168-140995-1- PB.pdf

ISSN 2444-4936

Aguilar, E. ., Peterson, T. C., Ramírez Obando, P., Frutos, R., Retana, J. A., Solera, M., Soley, J., González García, I., Araujo, R.M., Rosa Santos, A., Valle, V.E., Brunet, M., Aguilar, L.,Álvarez, L., Bautista, M., Castaños, C., Herrera, L., Ruano, E., Sinay, J. J., Sánchez, E., Hernández Oviedo, G. I., Obed, F., Salgado, J. E., Vázquez, J. L., Baca, M., Gutiérrez, M., Centella, C., Espinosa, J., Martínez, D., Olmedo, B., Ojeda Espinoza, C. E., Núñez, R., Haylock, M., Benavides, H., Mayorga, R. (2005). “Changes in precipitation and temperature extremes in Central America and northern South America, 1961-2003”. J. Geophys. Res., 110(D23107).

Balling Jr., R. C. & Idso, C. D. (2002). “Analysis of adjustments to the United States Historical Climatology Network (USHCN) temperature database”. Geophys. Res. Let., 29(10, 1387).

Beaulieu, C., Seidou, O., Ouarda, T. B., Zhang, X., Boulet, G., & Yagouti, A. (2008). Intercomparison of homogenization techniques for precipitation data. Water Resour. Res., 44(W02425), 1-20. doi:10.1029/2006WR005615

Brunet, M., Jones, P.D., Sigro, J., Saladie, O., Aguilar, E., Moberg, A., Della-Marta, P.M., Lister, D., Walther, A., and Lopez, D. (2007). “Temporal and spatial temperature variability and change over Spain during 1850 – 2005”. J. Geophys. Res., 112(D12117): DOI:10.1029/2006JD008249.

Brunet, M., Saladié, O., Jones, P., Sigró, J., Aguilar, E., Moberg, A., Lister, D., Walther, A., Lopez, D. and Almarza, C. (2006). “The development of a new dataset of Spanish Daily Adjusted Temperature Series (SDATS) (1850–2003)”. Int. J. Climatol., 26(13), pp. 1777 - 1802.

Brunetti, M., Maugeri, M., Monti, F. & Nanni, T. (2006). “Temperature and precipitation variability in Italy in the last two centuries from homogenised instrumental time series”. Int. J. Climatol., 26(3), pp. 345 - 381.

Davydova-Belitskaya, V. (2013). Informe de etapa I: "Estrategia regional para reducir la vulnerabilidad y mejorar la capacidad de adaptación al cambio climático en la región occidente". Guadalajara, Jalisco, Mexico: Universidad de Guadalajara - CONACYT.

Domonkos, P. (2011). Efficiency evaluation for detecting inhomogeneities by objective homogenisation methods. Theor Appl Climatol, 105, 455-467. doi: 10.1007/s00704-011-0399-7

Domonkos, P. (2013). Efficiencies of Inhomogeneity-Detection Algorithms: Comparison of Different Detection Methods and Efficiency Measures. Journal of Climatology, 2013(Article ID 390945), 15. Retrieved from http://dx.doi.org/10.1155/2013/390945

Domonkos, P., & Coll, J. (2017). Homogenisation of temperature and precipitation time series with ACMANT3: method description and efficiency tests. Int. J. Climatol., 37, 1910-1921. doi: 10.1002/joc.4822

Dumitrescu, A., Bojariu, R., Birsan, M.-V., Marin, L., & Manea, A. (2015). Recent climatic changes in Romania from observational data (1961–2013). Theor Appl Climatol, 122(1-2), 111-119. doi:10.1007/s00704-014-1290-0

Gubler, S., Hunziker, S., Begert, M., Croci-Maspoli, M., Konzelmann, T., Brönnimann, S.; Schwierz, C.; C. Oria, C.; Rosas, G. (2017). The influence of station density on climate data homogenization. Int. J. Climatol., 37, 4670–4683. doi:10.1002/joc.5114

Feidas, H., Makrogiannis, T. & Bora-Senta, E. (2004). “Trend analysis of air temperature time series in Greece and their relationship with circulation using surface and satellite data: 1955-2001”. Theor. Appl. Climatol., Volumen 79, pp. 185 - 208.

Feng, S., Hu, Q. & Qian, W. (2004). “Quality control of daily meteorological data in China, 1951–2000: a new dataset”. Int. J. Climatol., 24(7), pp. 853–870.

Gonzalez-Hidalgo, J. C., Peña-Angulo, D., Brunetti, M. & Cortesi, N. (2015). “MOTEDAS: a new monthly temperature database for mainland Spain and the trend in temperature (1951 - 2010)”. Int. J. of Climatol., 10 March 2015: DOI: 10.1002/joc.4298 [http://onlinelibrary.wiley.com/doi/10.1002/joc.4298/full: 8 de septiembre de 2015] .

Guttman, N. B. (1996). “Statistical characteristics of U. S. Historical Climatology Network temperature distributions”. Clim. Res., 6(1), pp. 33 - 43.

Hansen, J., Ruedy, R., Sato, M. & Lo, K. (2010). Global surface temperature change. Rev. Geophys., 14 December 2010, 48(RG4004). DOI: 10.1029/2010RG000345 [http://onlinelibrary.wiley.com/doi/10.1029/2010RG000345/epdf: 25 de agosto de 2015]

INEGI. (2013). Continuo de Elevaciones Mexicano 3.0 (CEM 3.0). Aguascalientes, Ags: Instituto Nacional de Estadística Geografía e Informática.

INEGI. (2014). Marco geoestadístico municipal 2014 versión 6.2. Aguascalientes, Ags: Instituto Nacional de Geografía Estadística e Informática.

IPCC, Intergovernmental Panel of Climate Change (2007). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. (S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, H. L. Miller, Edits.) Cambridge - New York, NY, United Kingdom and USA: Cambridge University Press.

IPCC, Intergovernmental Panel of Climate Change (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. (T. F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, P. M. Midgley, Edits.) Cambidge - New York, NY, United Kingdom and USA: Cambridge University Press.

Jones, P. D., & Moberg, A. (2003). “Hemispheric and large-scale surface air temperature variations: An extensive revision and an update to 2001”. J. Clim., 16(2), 206 - 223.

Jones, P. D., & Wigley, T. M. (2010). “Estimation of global temperature trends: what´s important and what isn´t”. Climate Change, 100, 59 - 69.

Jones, P. D., Lister, D., Osborn, T. J., Harpham, C., Salmon, M., & Morice, C. P. (2012). “Hemispheric and large-scale land-surface air temperature variations: an extensive revision and an update to 2010”. J. Geophys. Res. Atmos., 117: D05127. doi:10.1029/2011JD017139

Killick, R. E. (2016). Thesis for the degree of Doctor of Philosophy in Mathematics. Benchmarking the Performance of Homogenisation Algorithms on Daily Temperature Data. Exeter, U.K.: University of Exeter.

Lawrimore, J. H., Menne, M. J., E., G. B., Williams, C. N., Wuertz, D. B., Vose, R. S., & Rennie, J. (2011). “An overview of the Global Historical Climatology Network monthly mean temperature data set, version 3”. Journal of Geophisical Research Atmosphere, Volume 116: DI9.

NOAA, National Oceanic and Atmospheric Administration (1996). United States Historical Climatology Network (US HCN): Monthly temperature and precipitation data. (R. C. Daniels, T. A. Boden, D. R. Easterling, T. R. Karl, E. H. Mason, P. Y. Hughes, & D. P. Bowman, Edits.) TN, United States: NOAA.

Navarro R., R. (2015). Estudio de la variabilidad y tendencias del cambio climático en el estado de Jalisco durante el período 1961-2010. Biology undergraduate thesis, Zapopan, Jalisco, Mexico.

OMM Organización Meteorológica Mundial, 2010. Manual del Sistema Mundial de Proceso de Datos y de Predicción: Volumen I – Aspectos mundiales. Edición de 2010 ed. Ginebra: Organización Meteorológica Mundial.
OMM Organización Meteorológica Mundial, 2011. Guía de prácticas climatológicas. Ginebra: Organización Meteorológica Mundial.
OMM Organización Meteorológica Mundial, 2016. Directrices sobre mejores prácticas para el rescate de datos climáticos. Edición de 2016 ed. Ginebra: Organización Meteorológica Mundial.

OMM Organización Meteorológica Mundial, 2017. Directrices de la Organización Meteorológica Mundial sobre el cálculo de las normales climáticas. Edición de 2017 ed. Ginebra: Organización Meteorológica Mundial
PICC, Panel Intergubernamental sobre Cambio Climático (2001). Tercer Informe de Evaluación. Cambio Climático 2001: Resúmenes de los Grupos de trabajo. [http://www.grida.no/climate/ipcc_tar/vol4/spanish/pdf/wg1sum.pdf: September 8, 2015]

Ribeiroa, S., Cainetab, J., Costa, A., & Soares, A. (2015). Establishment of detection and correction parameters for a geostatistical homogenisation approach. Procedia Environmental Sciences, 27, 83-88. doi:10.1016/j.proenv.2015.07.115

Termonia, P.; Van Schaeybroeck, B.; De Cruz, L.; De Troch, R.; Caluwaerts, S.; Giot, O.; Hamdi, R.; Vannitsem, S.; Duchêne, F.; Willems, P.; Tabari, H.; Van Uytven, E.; Hosseinzadehtalaei, P.; Van Lipzig, N.; Wouters, J.; Vanden Broucke, S.; Van Ypersele, J.-P.; Marbaix, Ph.,; Villanueva-Birriel, C.; Fettweis, X.; Wyard, C.; Scholzen, Ch.; Doutreloup, S.; De Ridder, K.; Gobin, A.; Lauwaet, D.; Stavrakou, T.; Bauwens, M.; Müller, J.-F.; Luyten, P.; Ponsar, S.; Van den Eynde, P.; Pottiaux, E. (2018). The CORDEX.be initiative as a foundation for climate services in Belgium. Climate Servicies, 11, 49-61. doi:10.1016/j.cliser.2018.05.001

Universidad Autónoma de Guadalajara (2014). Plan Estatal de Acción ante el Cambio Climático en el estado de Jalisco, Guadalajara: UAG.

Vincent, L. A., Zhang, X., Bonsal, R., y Hogg, W. D. (2002). Homogenization of daily temperatures over Canada. Journal of Climatology(15), 1322-1334.

Vincent, L. A., Peterson, T. C., Barros, V. R., Marino, M. B., Rusticucci, M., Carrasco , G., y otros. (2005). Observed Trends in Indices of Daily Temperature Extremes in South America 1960-2000. American Meterological Society, 18:5011–5023.
http://dx.doi.org/10.1175/JCLI3589.1

Vincent, L. A., Wang, X. L., Milewska, E. J., Wan, H., Yang, F., y Swail, V. (2012). A second generation of homogenized Canadian monthly surface air temperature for climate trend analysis. Journal of Geophysical Research(117).

Vázquez Aguirre, J. L. (2010). Guia para el cálculo y uso de los índices de cambio climático en México. Puebla (Puebla): INECC.
Xu, W., Li, Q., Wang, X. L., Yang, S., Cao, L., y Feng, Y. (2013). Homogenization of chinese daily temperatures and analysis of trends in exrreme temperatures indices. Journal of Geophysical Research: Atmospheres, 118(17), 9708-9720.

Wang, X. L. (2003). Comments on “Detection of undocumented changepoints: A revision of the two-phase regression model". Journal of Climate 16(20): 3383-3385.

Wang, X. L., y Feng, Y. (2013). RHtestsV4 User Manual. Toronto, Canada: Climate Research Division Atmospheric Science and Technology Directorate Science and Technology Branch, Environment Canada.

Wang, H., Chen, Y., Xun, S., Lai, D., Fan, Y., y Li, Z. (2013). Changes in daily climate extremes un the arid area of northwestern China. Theoretical and Applied Climatology 112:15-28.

WMO (2009). Guidelines on Analysis of extremes in a changing climate in support of informed decisions for adaptation. Geneva: Switzerland.

Zhang, X., y Yang, F. (2004). RClimdex (1.0) Manual de Usuario. Ontario, Canadá: Climate Research Brand, Environment Canada.

Synthesis and characterization of silver nanoparticles using as a reducing agent plant extract of Dandelion (*Taraxacun officianale)*

Síntesis y caracterización de nanopartículas de plata utilizando como agente reductor extracto vegetal de Diente de León (*Taraxacun officianale)*

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Abstract

The objective of this work was to synthesize the synthesis of silver nanoparticles using as a reducing agent of ionic silver the plant extract of Dandelion *(Taraxacun officianale)*, vegetable of high availability and low cost, as an alternative to the processes conventional, based on the antioxidant capacity of plant extracts that reduce metals in solution. The nanoparticles prepared by this method were characterized by the golden yellow color characteristic of silver nanoparticle solutions. Measurements with UV-Vis spectroscopy of aqueous solutions of Ag1 + ions after coming into contact with plant extracts of Dandelion at different pHs showed an intense absorption band around 400-450 nm, characteristic of the resonance of the Plasmon of silver nanoparticles. Through the scanning of the samples by means of AFM *(atomic force microscopy)*, morphological information of the nanoparticles is obtained, from 3D topographic images of them, such as distribution, size and shape of the silver nanoparticles. Finally, its antibacterial activity was tested against the *Escherichia coli strain.*

Silver, Plant extracts, Nanoparticles

Resumen

El objetivo de este trabajo fue realizar la síntesis la síntesis de nanopartículas de plata empleando como agentes reductores de la plata iónica el extracto vegetal de Diente de León (*Taraxacun officianale)*, vegetal de alta disponibilidad y bajo costo, como una alternativa frente a los procesos convencionales, basada en la capacidad antioxidante de los extractos vegetales que reducen metales en disolución. Las nanopartículas preparadas por este método fueron caracterizadas por el color amarillo dorado característico de las disoluciones de nanopartículas de plata. Las mediciones con espectroscopia UV-Vis de las disoluciones acuosas de iones Ag^{1+} después de entrar en contacto con los extractos vegetales de Diente de León a diferentes pH, mostraron una banda de absorción intensa alrededor de los 400-450 nm, característica de la resonancia del plasmón de las nanopartículas de plata. A través del escaneo de las muestras por medio de AFM (*atomic force microscopy)* se obtiene información morfológica de las nanopartículas, a partir de imágenes topográficas 3D de las mismas, como distribución, tamaño y forma de las nanopartículas de plata. Finalmente, se comprobó su actividad antibacteriana frente a la cepa de *Escherichia coli*.

Plata, Extractos Vegetales, Nanopartículas

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Introduction

In recent years the synthesis of nanoparticles of noble metals has gained great importance because, on a nanometric scale, the physical and chemical properties of metals change with respect to bulk materials, properties that give them multiple applications, in the areas of medicine, technology and nanotechnology. Due to their large surface area on a nanometric scale, several metals have biocidal properties which have promoted the study of metal nanoparticles in order to use them as new antimicrobial agents (Sondi, 2004).

Among the noble metals, silver has excelled because in addition to presenting interesting optical, magnetic, electrical and catalytic properties, in the form of nanoparticles it also has biocidal or antimicrobial properties (Petica *et al.*, 2008). At present, silver nanoparticles have attracted the attention of many researchers because, depending on their size or shape, they have differentiated properties, which have been used in different industrial and commercial areas such as bactericides, in food packaging, in the immobilization of proteins, and in the development of optoelectronic materials and sensors, or even in the textile industry due to the different colorations that silver can present depending on its manometric shape and size (Khodashenas, 2015).

In this context, silver is a very attractive material to create nanoparticles focused on the treatment of various diseases caused by viruses or bacteria. The fact that the size of silver on a nanometric scale causes a significant increase in its antimicrobial potential is attributed to the fact that nanoparticles have a greater surface area in relation to volume compared to silver on a larger scale (Han, 2012), since Silver nanoparticles can bind to biological tissue proteins causing structural changes in the cell membrane and in the cell wall of bacteria, thus generating cell distortion and death (Ravindran *et al*., 2013). Therefore, it is evident that the antimicrobial activity or potential of silver nanoparticles strongly depends on the size and shape of the nanoparticles. (Pal *et al*., 2007).

Most of the methods described to date for the synthesis of silver nanoparticles use reducing agents such as hydrazine, sodium borohydride (NaBH4) and dimethylformamide (DMF).

All these are highly reactive chemicals and present potential environmental and biological risks (Monge, 2009). Due to this and due to its wide field of application there is a growing interest in developing environmentally friendly synthesis processes that avoid the use of toxic chemicals, such as biological synthesis that has emerged as an option to obtain nanoscale materials, this process It implies the use of microorganisms (bacteria, yeasts, fungi) or plant extracts (Sastry et al., 2003).

Plant extracts are a promising option because they contain reducing agents such as polyphenolic and flavonoid compounds with low redox potentials, suitable for the synthesis of silver nanoparticles (García, 2001). They belong to the group of polyphenolic compounds those whose structure has at least one aromatic ring substituted with one or more hydroxyl groups, and are found in nature mainly in fruits, vegetables, seeds and derived products (Naczk, 2006).

This paper presents an alternative synthesis of economical silver nanoparticles, simple and environmentally friendly, using water as a solvent and does not require strong and toxic reducing agents. The synthesis of silver nanoparticles was carried out using silver nitrate (*Sigma-Aldrich*) and as a reducing agent aqueous extract of Dandelion (*Taraxacun officianale*), vegetable chosen for its low cost and wide availability, within its chemical composition present polyphenols with high antioxidant capacity and low redox potentials such as Luteolin belonging to the flavonoid group. These compounds correspond to a group of polyphenolic secondary metabolites that are formed by an aromatic ring attached to at least one oxhydryl group (Bedascarrasbure *et al*., 2004). In Figure 1, the structure of the Luteolin (flavonoid) compound present in the Dandelion plant (*Taraxacun officianale*) (Cataya, 2001) is seen.

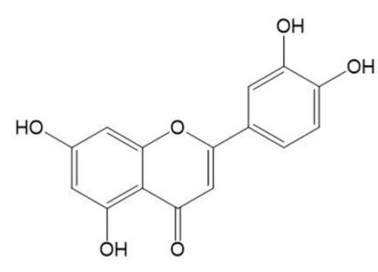

Figure 1 Chemical structure of Luteolin (flavonoid)

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In order to verify the antibacterial activity by the silver nanoparticles prepared with the dandelion plant extract and determine whether they have the property to inhibit the growth or development of bacteria, they were tested against the *Escherichia Coli strain*. (Rai *et al.,* 2012).

Methodology

The synthesis of metallic nanoparticles requires following an extremely rigorous synthesis protocol with the reagents used, such as their purity, the form and the order in which they are mixed and all kinds of physical and chemical factors, especially the concentration of the reagents, the temperature, the form and intensity of the stirring and the pH. To obtain the AgNPs silver nanoparticles, an aqueous solution of $AgNO_3$ 10^{-3} Molar (Sigma-Aldrich) was used, as the reducing agent of the ionic silver Ag^{1+} to Ag^0, the aqueous vegetable extract of Dandelion (*Taraxacun officianale*) was used). In order to determine the effect of the pH variation on the formation of silver nanoparticles, pH values of 5, 7 and 8 were worked, under the same concentration and temperature conditions.

Preparation of plant extracts

The dried leaves of Dandelion were crushed and the water-soluble components were extracted using the traditional methodology called infusion consisting of a solid-liquid extraction. 0.5 g of the ground plant material were taken and contacted with 100 mL of distilled water at 80° C until a volume of 70 mL was obtained, the Whatman No. 3 filter paper was filtered. Finally, each was preserved of the extracts in bottles in the refrigerator at 4°C until use (Arunachalan *et al*., 2012).

Synthesis of silver nanoparticles

The synthesis of silver NPs was carried out at room temperature, through the reduction of silver ions with the dandelion plant extract. The chemical reagents used and their concentrations were: $1x10^{-3}$ M $AgNO_3$ silver nitrate (Sigma-Aldrich), the dandelion plant extract and deionized water (18 MΩ cm^{-1}). For the pH adjustment, drops of a solution of sodium hydroxide (NaOH) (J. T. Baker) 0.5 M in water were added to the Dandelion extract until the desired pH value was adjusted.

The method consists in preparing the indicated solutions and combining them in glass vials in the following order: At 30 mL of the Dandelion extract at different pH values (5, 7, and 8) 10 mL of the $AgNO_3$ solution is added ($1x10^{-3}$ M) and kept under gentle stirring at room temperature for 10 minutes, thus promoting the formation of silver nanoparticles by reduction of Ag^+ ions.

Characterization

The silver NPs were characterized by UV-Vis spectrophotometry, a technique that has proven to be very useful for the rapid analysis of colloidal solutions of silver nanoparticles allowing to know if the synthesis process has concluded with the formation of nanoparticles. UV-Vis spectra were recorded with a double beam Lambda 35 (Perkin Elmer) spectrophotometer in a wavelength range between 350 and 800 nm using 1 cm optical path quartz cuvettes.

It is based on the fact that the reduction of metal ions produces solutions that in the case of silver have a yellow color with an intense band (plasmon resonance) between 400-450 nm indicating the presence of silver nanoparticles, behavior attributed to excitation collective of electrons on the surface of the particles (surface plasmonic absorption) (Kapoor, 1998). Said absorption spectrum has high sensitivity to changes in the morphology, size and dispersion medium of the nanoparticles (Cruz *et al*., 2012). This optical property of the appearance of plasmon resonance allows to characterize the metal nanoparticles including those of silver, in addition to being able to determine their formation and growth mechanisms.

On the other hand, through the scanning of the samples by means of atomic force microscopy AFM (*atomic force microscopy*) from 3D topographic images of them, information about the distribution, size and shape of the silver nanoparticles is obtained prepared (Oncins, 2014). These studies were carried out using a JEOL microscope, model JSPM-5200, equipped with a silicon nitride tip for scanning, of the μ-mash brand. The measurements were made at 20°C and at atmospheric pressure. Each sample in aqueous suspension was placed on a silicon wafer and allowed to evaporate at room temperature for one hour.

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The scanning conditions for the cantilever were: peak frequency of 275.393 KHz and a Q factor of 530.49, for the image acquisition conditions a speed of 666.67 µs was used up to 333.33 µs per line, the feedback filter was varied from 0.75 up to 1.6 Hz and the closed loop gain varied from 2 to 8.

Antibacterial activity

The method used for the bactericide test was disc sensitivity (Bernal, 1984). In Müller-Hinton agar plates, a mass of Escherichia coli strains was made, and the filter paper discs were placed at three points on the plate. Whatman No. 5 filter paper discs were previously impregnated for 8 hours in the dissolution of the silver nanoparticles prepared with the Dandelion extract, incubated at 24°C for 24 Hours.

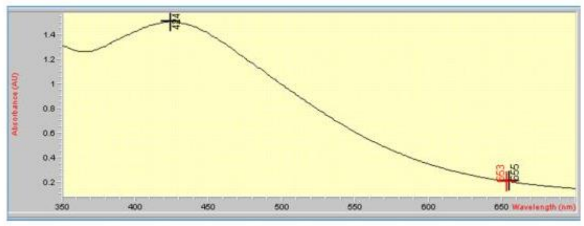
Results

The interaction of aqueous dandelion plant extracts at pH = 5, pH = 7 and pH = 8 with the silver nitrate solution resulted in golden yellow solutions in all cases, characteristic color of the silver nanoparticles, this as a consequence of the reduction of the Ag^{1+} ionic silver to Ag^0 metallic silver. Figure 2 shows the golden yellow color of the nanoparticles prepared with the Dandelion extract at pH = 8.

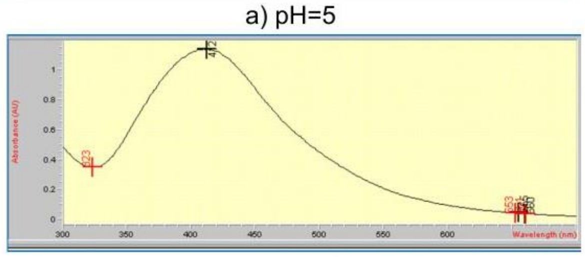
Figure 2 Dissolution of silver nanoparticles prepared with Dandelion extract at pH = 8

Measurements of UV-Vis spectroscopy of the aqueous solutions of $AgNO_3$ after coming into contact with the plant extracts of Dandelion at pH = 5, pH = 7 and pH = 8, showed intense absorption bands around 400-450 nm, characteristics of the plasmon resonance of silver nanoparticles, a result attributed to its formation.

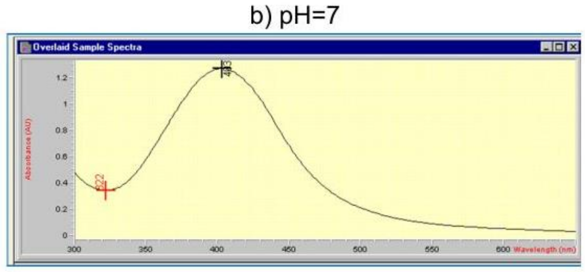
In Figure 3, the maximum absorbance band corresponding to the surface plasmon that appears with the samples in which the Dandelion extract was used at different pH values is observed, the band appearing at 424 nm for the case of the sample at pH = 5, at 412 nm at pH = 7 and at 403 nm at pH = 8.



a) pH=5



b) pH=7



c) pH=8

Figure 3 Absorbance spectra showing the surface plasmon band of silver nanoparticles formed with Dandelion extract a: a) pH = 5, b) pH = 7 and c) pH = 8

The shapes and positions of the absorbance bands obtained from the solutions of the prepared nanoparticles, in all cases reveal that they are polydispersed, the width of the bands indicates a wide distribution of the size of the nanoparticles, this effect is less in the sample with the pH = 8, and it can be inferred that the pH of the samples strongly influences their size and polydispersity.

From the comparison of the UV-Vis spectra of each of the samples of silver NPs obtained using Dandelion extract (*Taraxacun officianale*) at pH = 5, pH = 7 and pH = 8, the displacement of the band at shorter lengths with the increase in pH, accompanied by a decrease in the size of the nanoparticle, that is, resulting in smaller AgNPs size for the sample with pH = 8. This demonstrates the dependence of the particle size on the pH.

On the other hand, the appearance of a single shoulderless band (Sosa *et al*., 2003) is evidence that the nanoparticles obtained are spherical and, due to the position of the bands around 400 nm, it can be inferred that the size of the nanoparticles is approximately between 30 and 20 nm.

Table 1 presents a summary of the results corresponding to the color of the prepared solutions and wavelength in which the maximum absorbances corresponding to the surface plasmon resonance appear.

AgNPs prepared at different pH	Observed color	Wavelength corresponding to the peak absorbance of plasmon
pH= 5	Golden yellow	424 nm
pH = 7	Golden yellow	412 nm
pH = 8	Golden yellow	403 nm

Table 1 Color and wavelength of the absorbance band corresponding to the plasmon resonance of AgNPs obtained with Dandelion extract at different pH values

To confirm the size and distribution of the silver nanoparticles obtained, they were characterized by AFM Atomic Force Microscopy (JSPM-5200 Equipment). The topographic study carried out on the samples makes it possible to determine the presence of nanoparticles in the form of aggregates, as well as their morphology and their size distribution intervals.

Figures 3, 4 and 5 show the photographs of the different scans performed on the sample of silver nanoparticles obtained with the dandelion aqueous extract at pH = 8.

Figure 4 shows the topographic AFM image (5.50 µm x 5.50 µm x 170.4 nm) in shaded mode of the silver nanoparticles obtained with the Dandelion extract, where submicrometric and semi-parchromatic morphology particles are seen, disseminated homogeneously on the surface of the silicon wafer.

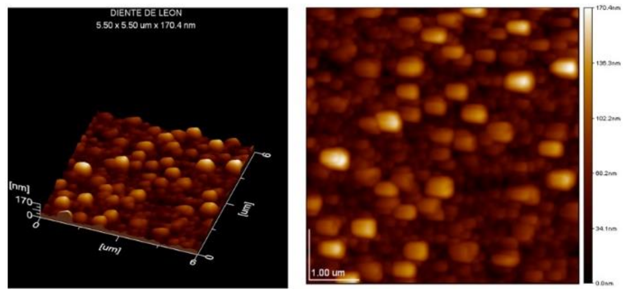


Figure 4 Scanning image of 5.5 µm x 5.5 µm x170.4 nm, in shaded mode of nanoparticles prepared with Dandelion extract

Figure 5 shows the topographic AFM image with a scanning scale of 2.01 µm x 2.01 µm x 140 nm, in which an amplification of Figure 4 is observed, where the particle cluster distributed in more detail can be seen Silicon wafer. In the images, hemispherical and semiprimatic particles, apparently nanometric, can be seen.

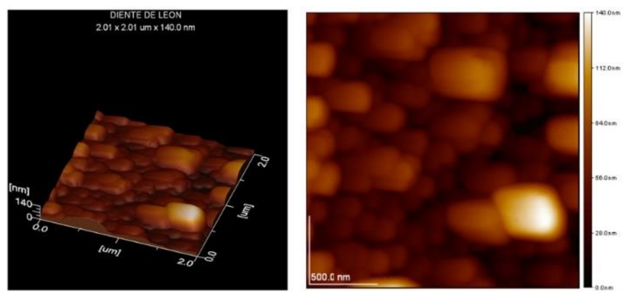


Figure 5 Scanning image at 2.01 µm x 2.01 µm x 140.0 nm "shaded" mode of nanoparticles prepared with Dandelion extract

In Figure 6, the AFM image is presented by topography (1.00 µm x 1.00 µm x 73.0 nm), in an amplification of approximately 1 μm^2, where two morphologies are observed, which were previously seen as semi-prammatic can be seen with greater detail in this amplification so it can be determined that they have the shape of flakes of the order of 180 to 200 nm long and 100 to 150 nm wide approximately, and the second morphology consists of hemispherical nanometric particles of the order of 20 to 30 nm.

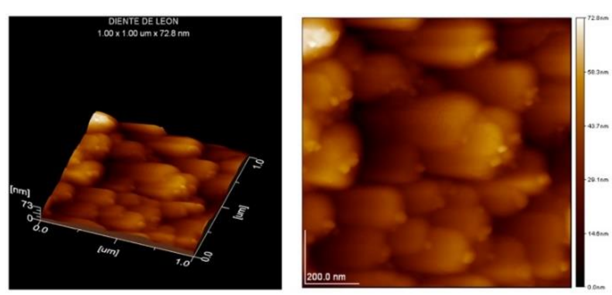


Figure 6 Scanning images at 1.0 µm x 1.0 µm x 72.8 nm "shaded" mode of silver nanoparticles prepared with Dandelion extract

An amplification of the same area of the film (256 nm x 256 nm x 28.9 nm) is shown in Figure 7, in which the hemispherical morphology of the particles deposited on a film formed by flakes, probably due, is observed in greater detail to some other component of the solution, on the other hand, it is confirmed that the diameter of one of these particles is 25.9 nanometers. The image allows to detect the shape of small hemispherical particles as expected according to the results of the electronic absorption spectra in the visible region.

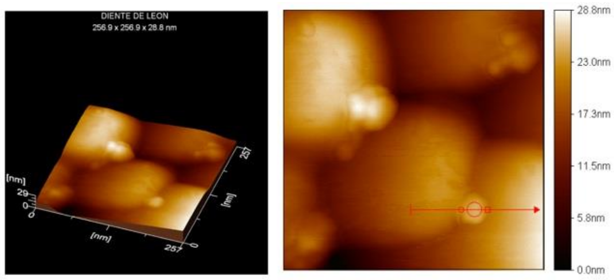


Figure 7 Scanning images at 256.9 nm x 256 nm x 28.8 nm, shaded mode of silver nanoparticles prepared with Dandelion extract, showing the size of a 25.9 nanometer nanoparticles

Test of silver nanoparticles obtained with Dandelion extract as a bactericide

After 24 hours of sowing, the plate was verified with the *Escherichia.coli* strain, clearly showing halos of inhibition in the three points where the filter paper discs impregnated with the colloid of silver nanoparticles prepared with the Tooth extract were placed. Lion.

The antibacterial action was quantified using Bauer's methodology (Bauer *et al*., 1966), which consisted of measuring the diameter of the bacterial growth inhibition halo around Whatman No. 5 filter paper discs impregnated with the prepared silver nanoparticles. Figure 8 shows the plaque where inhibition halos are clearly observed, and Table 2 shows the results of their measurements.

A moderate activity is observed on the *E. coli* strain, in the three points of the application of the nanoparticle colloid, considered as evidence of its effectiveness as a bactericide against the *Escherichia coli strain.*

Figure 8 Plaque showing the halos of inhibition of AgNPs against *E. coli.*

Number	Diameter of inhibition halos.
1	10 mm
2	12 mm
3	8 mm

Table 2 Measurements of the halos of inhibition of AgNPs against *E. coli.*

Conclusions

The synthesis of silver nanoparticles was developed by applying an environmentally friendly method, compared to the chemicals that originate unwanted by-products. For this reason, the use of the Dandelion aqueous extract is economical and less harmful to the environment and with successful results for the synthesis of nanoparticles. The colloids obtained in all cases presented the golden yellow color characteristic of silver nanoparticles.

The UV-Vis analysis allowed to corroborate the formation of silver nanoparticles in a state of zero oxidation through the absorption response in the blue-violet region (400 nm - 490 nm) that characterizes this metal. The prepared nanoparticles were also characterized by AFM Atomic Force Microscopy, a study that confirmed the formation of silver nanoparticles, revealing the areas where the nanoparticles are added, as well as their morphology and their varied sizes. A moderate activity of the AgNPs prepared on the *Escherichia coli* strain, considered as evidence of its effectiveness as a bactericide against this strain is observed.

References

Arunachalam, K. D., Annamalai, K. S., & Hari, S. (2013). One-step green synthesis and characterization of leaf extract-mediated biocompatible silver and gold nanoparticles from Memecylon umbellatum. *International Journal of Nanomedicine.* 8, 1307-1315.

Bedascarrasbure, E., Alvarez, A., & Rodríguez, E. (2004). Contenido de Fenoles y Flavonoides del Propoleos Argentino. *Acta Farm*. Bonaerense, 23 (3), pp. 369-72.

Bauer, A. W., Kirby, M. M., Sherris, J.C., & Turck, M. D. (1966). Antibiotic susceptibility testing by a standardized single disk method. *The American Journal of Clinical Pathology*, Vol. 36, No. 3, 493-496.

Bernal, M. R., & Guzmán, M. U. (1984). El antibiograma de discos. técnica de Kirby-Bauer. *Biomédica*, Vol. 4, No. 3-4.

Cartaya, O. Reynaldo, I. (2001). Flavonoides: Características químicas y aplicaciones. *Cultivos Tropicales*, vol. 22, No. 2, pp. 5-14.

Cruz, L. D., Rodríguez, M. C., López, L. J. & Herrera, V. M., Orive1, G. A. Creus, H. A. (2012). Nanopartículas metálicas y plasmones de superficie una relación profunda. *Avances en Ciencias e Ingeniería*, 3(2), pp. 67-78.

García, L., Rojo, D. M., & Sánchez, E. (2001). “Plantas con propiedades antioxidantes”. *Revista Cubana de Investigación* Biomédica, 20(3): 231-235.

Han R. M., Zhang, J.P., & Skibsted, L. H. (2012). Reaction Dynamics of Flavonoids and Carotenoids as Antioxidants. *Molecules.*, 17: 2140-2160.

Kapoor, S. (1998). Preparation, characterization, and surface modification of silver nanoparticles. *Langmuir*, 14, pp. 1021-1025.

Khodashenas, B., & Ghorbani, H.R. (2015). Synthesis of silver nanoparticles with diff erent shapes. *Arabian Journal of Chemistry*. http://dx.doi.org/10.1016/j.arabjc.2014.12.014.

Monge, M. (2009). Nanopartículas de plata: métodos de síntesis en disolución y propiedades bactericidas. Real Sociedad Española de Química. *An. Quím*., 105(1), pp. 33−41.

Naczk, M. & Shaidi, F. (2006) Phenolic in Cereals, Fruit and Vegetables: Occurrence, Extraction and Analysis. Journal of *Pharmaceutical and Biomedical Analysis*, 41, 1523-1542.

Oncins G., & Díaz, J. (2014). La microscopia de fuerzas atómicas. ResearchGate. https://www.researchgate.net/publication/271133769.

Petica, A., Graviliu, S., Lungu, M., Buruntea, N., & Panzaru, C. (2008). Colloidal silver solutions with antimicrobial properties. *Materials Science and Engineering*: B, 152, pp. 22-27.

Pal, S., Tak, Y.K., & Song, J.M. (2007). Does the Antibacterial Activity of Silver Nanoparticles Depend on the Shape of the Nanoparticle? A Study of the Gram-Negative Bacterium Escherichia coli**.** *American Society for Microbiology*. Vol. 73, No. 6 p. 1712–1720.

Raveendran, P J., Fu, S. L., & Wallen, J. (2003). Completely “Green” Synthesis and Stabilization of Metal Nanoparticles. *J. Am. Chem. Soc*., 125, 13940–13941.

Ravindran, A., Chandran, P., & Khan, S. (2013). Biofunctionalized silver nanoparticles: Advances and prospects. *Colloids and Surfaces B: Biointerfaces*, Vol. 115, pp. 342-352.

Sastry, M., Ahmad, A., Khan, I., & Kumar, R. (2003). Biosynthesis of metal nanoparticles using fungi and actinomycete. *CURRENT SCIENCE*, Vol. 85, No. 2, pp. 162-170.

Sondi, I., & Salopek-Sondi, B. (2004). Silver nanoparticles as antimicrobial agent: a case study on E. coli as a model for Gram-negative bacteria. *Journal of Colloid and Interface Science,* 25, pp. 177-182.

Sosa, I. O, Noguez, C., & Barrera R.G. (2003). Optical Properties of Metal Nanoparticles with Arbitrary Shapes. *Journal of Physical Chemistry B*: 28. Pp. 6269-6275.

Rai M., Deshmukh S., Ingle A. & Gade A. (2012). Silver nanoparticles: the powerful nanoweapon against multidrug-resistant bacteria. *Journal of applied Microbiology*. 112: 841-852.

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Comparative study between natural, entomophilic and manual pollination in soursop (*Annona muricata* L.)

Estudio comparativo entre polinización natural, entomófila y manual en guanábana (*Annona muricata* L.)

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Abstract

This research was carried out in the communities of Tonino and Divisadero municipality of Compostela, Nayarit, Mexico with the objective of studying the effect of natural, entomophilic and manual pollination of soursop fruits. Pollinations were carried out during the June-July period of 2017 (summer flowering). Which treatments consisted of the natural pollination that only perforated bagging was placed, The variables were: peduncle diameter, brush or strawberry diameter, percentage of yield, percentage of fruit fall, dynamics or general kinetics of growth variables and general behavior of loss and fruit fall. Percentage yield as it was low from 6 to 21% and this decreased as the evaluation time elapsed due to the fall in fruit. The fall of the fruit of the three treatments was considered to have a very important factor whereby they fell, the lack of coverage with fungicides or insecticides.

Pollination, Types of pollination, Soursop, Insects

Resumen

La presente investigación se realizó en las comunidades del Tonino y Divisadero municipio de Compostela, Nayarit, México con el objetivo de estudiar el efecto de la polinización natural, entomófila y manual de frutos de guanábana. Las polinizaciones se llevaron a cabo durante el periodo de junio-julio del año 2017 (floración de verano). Las cuales los tratamientos consistieron en la polinización natural que únicamente se le colocó el embolsado perforado, Las variables fueron: diámetro de pedúnculo, diámetro de cepillo o frutilla, porcentaje de prendimiento, porcentaje de caída de fruto, dinámica o cinética general de variables de crecimiento y comportamiento general de prendimiento y caída de fruto. Porcentaje prendimiento ya que fue bajo de un 6 al 21 % y este disminuyó conforme transcurrió el tiempo de la evaluación debido a la caída de fruto. La caída de fruto de los tres tratamientos se les consideró que tuvieron un factor muy importante por la cual cayeron los mismos, la no cobertura con fungicidas ni tampoco insecticidas.

Polinización, Tipos de polinización, Guanábana, Insectos

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Introduction

Soursop (Annona muricata L.) is native to tropical America, it is dispersed in Mesoamerica, the West Indies and Brazil. In the United States it only grows in South Florida (Can Pech, 1981). The genus Annona groups around 100 native species of the American continent, however, only six have commercial importance: soursop (A. muricata L), saramuyo (A. squamosa L), ilama (A. diversifolia Safford), chincuya (A. purpurea), custard apple (A. reticulata L), custard apple (A. cherimola Mill.) and the atemoya hybrid (A. cherimola XA squamosa) (Nakasone and Paul, 1997).

Soursop is one of the most appreciated fruit trees in the tropics of Central and South America, due to its pleasant taste and aroma, since these have allowed increasing demand in the foreign market and its commercial value (Saunders and Coto, 2001).

Among the countries with the largest sown area of soursop is Mexico with 2,964.10 ha, distributed as follows: Nayarit with 1,985.10, Colima 368.00, Michoacán 240.00 and Guerrero 177.00 ha respectively. According to statistical production data for the soursop case, 1,985.10 ha were sown in Mexico, 1,711.10 ha were harvested with a production of 10,695.06 t of fruit and yields ranging from 6.25 to 12.7 t.ha-1 with a national average of 7.98 t .ha-1. The cultivation area occupied by the Guanabana Nayarita is located in the municipality of Compostela, between Las Varas and La Peñita de Jaltemba with a cultivated area of 1,907.00 ha and production of 10,137.00 t; and San Blas, with 52.40 ha and production of 401.38 t in the coastal zone of the State (SIAP, 2015).

Soursop cultivation presents several problems among them, pollination stands out, these flowers in technified crops are artificially pollinated for a growth between 18 and 23% of production (Melo, 2002).

On the other hand (Guzmán, 1991) in the soursop, custard apple and atemoya crops it was able to increase the production between 30 and 50% which was additionally reflected by the increase in weight, size and greater mooring of fruits per plant.

The processes of pollination and fertilization in flowers of A. muricata L, are limited by characteristic phenomena of the flower, the gynoecium is apocarpic, formed by the union of numerous pistils (Manica, 1997), in addition to pre-synthesis and early precedent the flower presents a closed structure, hindering pollination by wind and relatively large insects (Cogez and Lyannaz, 1994), do not produce nectar; also presenting the phenomenon of heterostilia (Pinto and Genú, 1984).

The ignorance of the physiology of flowering is based on the fact that the soursop flower is hermaphroditic and as such, it is assumed that, by presenting the male and female organs in each flower, pollination and fertilization will be successful. However, even if it is arranged in the same place, the anonaceae present the problem of protogyneal dicogamy (early maturation of the gynoec in relation to androceous), which prevents successful pollination and fertilization (Guzmán, 1981).

Due to the above, it seeks to solve the problem of pollination, mooring and deformity of soursop fruits with the application of the pollination technique.

Objective

The objective of this work was to study the effect of natural, entomophilic and manual pollination on the mooring of soursop fruits.

Methodology to be developed

The present investigation was carried out in a soursop orchard located in the town "El divisadero", in the municipality of Compostela, Nayarit, Mexico. Geographically it is located at 21º 08 '34.54 ”N, 105º 12' 38.82” W, with an altitude of 197 m (Available at: https://es.wikipedia.org/wiki/Municipality_of_ Compostela (Nayarit). Accessed March 2 from 2017).

Trees from a soursop orchard, approximately 10 years old, were used; with a distance between plants of 7 x 7 m. A randomized block design with five repetitions was used. The experimental unit was formed by a tree, in which 20 flowers were selected.

The treatments consisted of applying three flowers pollination techniques (table 1) of soursop distributed in trees located in an orchard in Compostela, Nayarit, Mexico.

Treatment	Pollination	Process
1	Natural	Natural maturation of carpels and stamens
2	Entomophilic	A beetle of **Phyllophaga spp** was placed by flower
3	Manual	Pollen application with the help of a brush on receptive flowers

Table 1 Soursop flowers pollination techniques (Annona murucata L) in an orchard located in Compostela, Nayarit Mexico

Pollinations were carried out during the June-July period of 2017 (summer flowering).

The natural pollination consisted of placing the bagging in flowers that were in a state of maturity or receptive equal to those that would be pollinated entomophilically and manually, piercing the bags to avoid water accumulation

For entomophilic pollination, beetles (Phyllophaga sp.) Collected manually during the night were used, using the light from the houses as a trap. The beetles were placed in a perforated container, which were impregnated with pollen from the same flowers that had been collected the day before; the individuals were placed in a previously perforated plastic bag. This container was placed on the newly opened flower for a time of 24 hours.

Manual pollination consisted of collecting mature (open) flowers of state IV of the soursop phenology, the flowers were collected during an afternoon prior to pollination, the flowers were allowed to rest in paper bags at room temperature, the next day the chalice and petals were removed, only stamens with pollen were preserved, this powder was deposited in the stigma of slightly open flowers presenting states II and III; These stages indicate the induction and floral initiation (formation of buds), respectively. This process was carried out from 9:00 am to 12:00 pm with the support of a # 7 brush with soft hair.

Evaluated variables

Peduncle diameter (cm). This variable was obtained by measuring the thickness with the help of a flexometer every 7 days from 36 days after the pollination of flowers.

Brush or strawberry diameter (cm). The diameter of this variable was measured with the help of a flexometer every 7 days from 36 days after pollination.

Percentage of yield of fruits by pollinated flowers (%). For this variable, the number of lit flowers multiplied by one hundred was determined, among the number of pollinated flowers

Percentage of fall of fruit by some pathogen (%). The number of fruit drop per hundred was determined, among the number of pollinated flowers.

General dynamics or kinetics of growth variables. This variable was obtained from the general averages of the five samples of the growth variables referred to in peduncle length, peduncle diameter, brush length, and brush diameter.

General behavior of loss and fall of fruit. This variable was obtained from the general averages of the five samples of the percentages of yield and fall of fruit.

Statistic analysis

Variance analysis was applied to the variables evaluated and those that showed significant differences were tested for means using the Tukey method (α = 0.05). For this, the statistical package SAS (Statistical Analysis System) (Castillo, 2011) was used.

Results

During the evaluation of three pollination techniques in soursop flowers distributed in 10-year-old trees, the results were as follows. The yield of the fruits occurred at 36 days after pollination (pdp), among these, in the pollination techniques a significant statistical presence is observed in percentage of yield with 12.5% and highly significant in peduncle diameter with 1.88 cm On average, at (43ddp) there was a significant difference in percentage of yield decreasing according to 36 ddp with 10% due to the fall of the flowers due to the presence of fungi and insects, in the last variable this difference is maintained at the 50 ddp, which indicates that the response of these variables was a function of the type of pollination (Table 2).

VARIABLE	P>F	GENERAL MEAN
36 days after pollination		
Peduncle length (cm)	0.1908ns	2.53
Brush or strawberry length (cm)	0.1251ns	2
Peduncle Diameter (cm)	<.0001**	1.88
Brush or strawberry diameter (cm)	0.0009**	2.91
Percentage of ignition (%)	0.0112*	12.5
Fruit Drop Percentage (%)	0.005**	88.33
43 days after pollination		
Percentage of ignition (%)	0.0359*	11.88
Fruit Drop Percentage (%)	0.0107*	93.67
50 days after pollination		
Percentage of ignition (%)	0.1192ns	10
Fruit Drop Percentage (%)	0.025**	94.67

Table 2 Results of the analysis of variance and general mean of the variables evaluated in soursop flowers naturally pollinated, by Coleoptera of Phyllophaga spp and manual with brush support. When Pr> F is less than 0.05, there are significant differences. * Presence of differences. ns Absence of differences

In (36 ddp), the coefficient of variation (table 3) ranged from 51.66 to 7.23%, values that according to the development of the experiment are considered to be within a justifiable range, since it corresponds to the settling response and fall of fruit, variables that can be related by poor or late pollination (Escobar et al., 1986).

VARIABLE	CV (%)
36 days after pollination	
Peduncle length (cm)	12.78
Brush or strawberry length (cm)	61.17
Peduncle Diameter (cm)	15.47
Brush or strawberry diameter (cm)	49.23
Percentage of ignition (%)	51.66
Fruit Drop Percentage (%)	7.23
43 days after pollination	
Percentage of ignition (%)	36.06
Fruit Drop Percentage (%)	6.24
50 days after pollination	
Percentage of ignition (%)	41.33
Fruit Drop Percentage (%)	5.37

Table 3 Results of the coefficient of variation of the variables evaluated in naturally pollinated soursop flowers, by Phyllophaga spp beetle and manual with brush support

The low percentage of yield or fruit set of manually pollinated fruits could be due to the inadequate selection of flowers during pollination (lack of receptivity) which resulted in the absence of fertilization, events occurred in this experiment and that decreased and increased the yield percentages respectively as the study period elapsed; Escobar et al. (1986), indicate that this situation can be overcome by manual pollination technique.

The R2 indicates that the model used explains 88 and 72% of the variability in the growth variables; that is to say, for pedicel diameter and brush diameter, respectively, and 56 and 59% for percentage of pregnancy and percentage of abortion; in these last variables, the proportion decreased and increased gradually, as the evaluation time elapsed (Table 4).

VARIABLE	R^2
36 days after pollination	
Peduncle length (cm)	0.26
Brush or strawberry length (cm)	0.31
Peduncle Diameter (cm)	0.88
Brush or strawberry diameter (cm)	0.72
Percentage of ignition (%)	0.56
Fruit Drop Percentage (%)	0.59
43 days after pollination	
Percentage of ignition (%)	0.74
Fruit Drop Percentage (%)	0.53
50 días después de la polinización	
Percentage of ignition (%)	0.57
Fruit Drop Percentage (%)	0.46

Table 4 R^2 results of the variables evaluated in naturally pollinated soursop flowers, by Phyllophaga spp coleoptera and manual with brush support

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Conclusiones

The type of pollination affected the growth, yield and fall of fruits.

Natural pollination contributed to a higher proportion of yield and a lower proportion of fruit fall compared to entomophilic and natural pollination, as well as a larger peduncle diameter.

Based on the diameter of the brush or strawberry, it was observed that natural pollination exceeded that of manual and entomophilic way.

It was identified that the three different types of pollination have a highly low yield percentage ranging between 6 and 21%.

It was observed that the trend was directly proportional, as the days after pollination go by they grow both in length and in diameter.

It was attributed that the lack of coverage with fungicides and insecticides could be a very important factor for the fall of the fruit since it developed symptoms that reflected fungal diseases.

The use and handling of perhaps infected materials were also part of the fall of pollinated flowers and developed fruits.

The selection of flowers is very important for pollination in the three treatments since if the flowers are not yet ready for this process it can reduce fruit set.

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References

Can Pech, V. 1981. Colecta y caracterización de la guanábana (*Annona muricata* L.) en el trópico húmedo de México. Anteproyecto de Tesis. Universidad Autónoma de Chapingo, Departamento de Fitotecnia. 27 p.

Castillo, M. L. E. 2011. Introducción al SAS para Windows. Universidad Autónoma Chapingo. Departamento de Parasitología Agrícola. Tercera edición. Primera reimpresión. Chapingo, Estado de México.

Cogez, X. y Lyannaz, J. P. 1994. Manual pollination of sugar apple. Tropical Fruit Newsletter 19: 5-6.

Escobar, W. y Sánchez. L. 1992. Control de plagas y enfermedades del guanábano. Boletín de sanidad vegetal 07. ICA. Separata del manual Fruticultura Colombiana Guanábano. Produmedios, Bogotá, pp. 61-78.

Guzmán, F. 1981. Eficiencia de la polinización artificial en las flores de guanábana (*Annona muricata* L.). Facultad de Agronomía. Universidad del Tolima. Ibagué, Colombia. 37 p.

Manica, I. 1997. Taxonomía, morfología e anatomía. In: Reboucas S. J., I. Vilas B., O. Magalhaes M. e T. Hojo R. (Eds.). Anonáceas. Producâo e mercado. (Pinha, graviola, atemóia e cherimólia). UESB. Bahia, Brasil. pp. 20-35.

Nakasone, H. Y. and Paul, R. E. 1997. Tropical fruits. CAB International. USA. pp. 45-75.

Pinto, A. C. e Genú, P. J. 1984. Contribuçao ao estudo técnico científico da graviola (*Annona muricata* L). Anais do VII Congresso Brasileiro de Fruticultura. 2: 529-546.

Saunder, J. L. y Coto, A D. 2001. Insectos plaga de la guanábana (Beepehr at) Costa Rica. Manejo de plagas 61: 60-68.

Sistema de Información Agroalimentaria y Pesquera (SIAP, 2015). COM. MX.

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Evaluation of inhibitor effect on micelium development on *Fusarium oxysporum, y F. solani*, using three dosis of epazote epazote (*Chenopodium ambrosioides* L.)

Evaluación del efecto inhibidor del desarrollo micelial en *Fusarium oxysporum, y F. solani*, bajo tres dosis de extracto crudo de epazote (*Chenopodium ambrosioides* L.)

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Abstract

Using natural extract of epazote (*Chenopodium ambrosioides* L.), has shown to control phytopatogenic fungi (P. Aguilar *et al.*, 2013; y J. Black Solis *et al.*, 2017). One mililiter of ethanolic extract at concentrations of 25%, 50%, 100% diluted on sterile distilled water (V:V) has been used to inhibit micelial developement of *Fusarium oxysporum,* and *Fusarium solani,* added to PDA Petri dish under a completely randomized experimental design, a statistical analysis was carried out by means of an ANOVA and comparison test of means with Tukey´s multiple range. After eight days of incubation, the outstanding inhibit effect has been observed with 100% and the average diameter of colonies was 62 mm., has been measured on both fungi species. In contrast, 62 mm., and 61 mm., was observed on *F. oxysporum* and *F. solani* respectively, and a statistical effect was observed ($p \leq 0.05$). With 25% and 50%, micelial inhibit developement has been measured, but no statistical differences between concentrations has been calculated ($p \geq 0.05$) for both fungi. The results suggest that ethanolic extract of epazote could be used to control both phytopathogenic fungi.

Epazote, Extract, Phytopathogenic fungi

Resumen

El empleo de extractos naturales de epazote (*Chenopodium ambrosioides* L.), ha tomado un papel importante para el control de hongos fitopatógenos (P. Aguilar *et al.*, 2013; y J. Black Solis *et al.*, 2017) El objetivo de este trabajo fue evaluar el efecto inhibidor del crecimiento micelar en *Fusarium oxysporum,* y *Fusarium solani,* usando tres dosis de extracto crudo de epazote a: 25%, 50%, 100% diluidas en agua destilada estéril (V:V) y un testigo absoluto, incorporando 1 mL., de la dilución en placa con PDA más el inóculo, con tres repeticiones por tratamiento. Se aplicó un análisis de varianza (ANOVA) y comparación de rango múltiple (Tukey). Posterior a ocho días de incubación, se observó un mayor efecto inhibitorio; el diámetro colonial promedio fue de 15 mm, bajo la concentración del 100% para ambas especies; en contraste, se registró un diámetro promedio de 62 mm y 61 mm., en *F. oxysporum* y *F. solani* respectivamente con el testigo absoluto; con una diferencia significativa ($p \leq 0.05$). Bajo las concentraciones de 25% y 50% se observó inhibición en el desarrollo micelial pero sin diferencias significativas ($p \geq 0.05$).Los resultados sugieren la aplicación de extracto de epazote para controlar del crecimiento miceliar *F. oxysporum* y *F. solani*.

Epazote, Extracto, Hongos fitopatógenos

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Introduction

In current agriculture, the practices that refer to conserving and generating the least impact on native populations have become relevant. In this sense, the control of pathogenic organisms to crops has turned its management towards treatments with molecules of organic origin, reducing the restrictions on the use of traditional control with synthetic molecules.

Fusarium oxysporum and *F. solani* have been clearly identified as phytopathogens in chili, corn, tomato, strawberry, and many others (Hernández-Delgado, Ángel Reyes-López, Gerardo García-Olivares, Mayek-Pérez, & Reyes-Méndez, nd; Mayens Vásquez-Ramírez & Castaño-Zapata, 2017; Morales-López, Torres-Arteaga, Salas-Galván, et al., 2017; Nam, Park, Kim, & Yoo, 2009).

Based on the above, controlling the invasions of these organisms has been a priority; aqueous extracts of clove spices (*Eugenia caryophyllata*) cinnamon (*Cinnamomum zeylanicum*); and Mexican oregano (*Lippia berlandieri*) (Rueda de León, Vargas, Muñoz, Muñoz Castellanos, & Ochoa, 2013), phenolic extracts of chilpetin fruits (Rodriguez-Maturino et al., 2015), by Heliopsis longipes L., (Morales -Lopez, Torres-Arteaga, E., et al., 2017; Morales-López, Torres-Arteaga, Salas-Galván, et al., 2017) (Morales-López, Torres-Arteaga, Salas-Galván, et al. , 2017; Susana, Flores López, Benavides Mendoza, & Flores Olivas, 2011), Galla chinensis, GC., And 1% tannic acid (Forrer et al., 2014),

Epazote (*Chenopodium ambrosioides L.*) is a plant native to Mexico used as a condiment or recognized to treat various stomach pains and intestinal parasites (Ferreira et al., 2019; Potawale et al., 2008; Vibrans, 2009).

The extract of this plant has been registered as a biochemical pesticide before the EPA (Anonymous, 2011), with antifungal activity (Jardim et al., 2010; Shah, Nisar, Suhail, & Bacha, 2014) and its essential oils (Aguilar et al., 2013; Black Solis, Ventura Aguilar, Barrera Necha, & Bautista Baños, 2017) have shown an antifungal activity against *F. oxysporum*.

This due to the presence of bioactive compounds such as ascaridol (Aguilar et al., 2013), likewise, ethanolic extracts of dried leaves of epazote (*Chenopodium ambrosioides*) in mature and immature state on the inhibition of in vitro mycelial growth of Colletotrichum gloeosporioides, *Fusarium oxysporum*, Alternaria alternata, and Botrytis cinerea proved effective to inhibit the mycelial development of these fungi (Cabrera Calderón, Rivera Rebollar, Lira Vargas, Trejo Marquez, & Pascual Bustamante, 2016). At a concentration of 100 µg / L., C. ambriosioides leaf oils showed an antifungal effect, against F. oxysporum and other fungi that invade stored grains (Kumar, Mishra, Dubey, & Tripathi, 2007).

Materials and Method

a) Obtaining crude extract.

The plant material that was used to obtain essential oils were previously dehydrated epazote leaves, being exposed to the environment for two continuous weeks. In the Soxhlet, 20 grams of the plant material plus 350ml of absolute ethanol as solvent were placed (Aldrich Chemical Co. Mexico, DF) (Cabrera Calderón et al., 2016; Ferreira et al., 2019; Kumar et al., 2007; Susana et al., 2011); The packing column was formed by the previous mixture covered with sterile cotton in an Italian type glass distiller and kept boiling (97 ° C) for 4h. The essential oils were stored in amber bottles at room temperature; three extractions were made obtaining a total of 550 ml of solution. To remove the solvent from the extract, a simple distillation was performed, obtaining 18ml of essential oils.

b) Dosage formulation:

Three different doses and one absolute control were used as treatments (table 1), by the method of diluting ethanolic extract in sterile distilled water, in v / v ratio, in 50ml flasks. In total, 17.5ml of ethanol extract were used (Aguilar-Alonso, Navarro-Cruz, Sanchez-Flores, Meneses-Sánchez, & Avila-Sosa, 2013).

Witness	No extract; 0 mL., Of extract in 10 mL of sterile distilled water; 0: 1 v / v
Treatment I	25% concentration of extract; 2.5 mL of extract in 7.5 mL., Of sterile distilled water; 1: 3 v / v
Treatment II	50% concentration of extract; 5 mL of extract in 5 mL., Of sterile distilled water; 1: 1 v / v
Treatment III	100% extract concentration; 10 mL of extract in 0 mL., Of sterile distilled water; 1: 0 v / v

Table 1 Concentration of *C. ambriosioides* extracts

c) Mycelial growth inhibition assays:

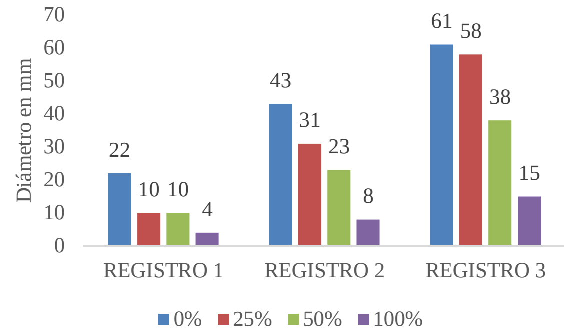
The trial was conducted with strains of Fusarium solanii, and F. oxysporum, which were kindly provided by Dr. Marcia M. Martínez S., professor-researcher of the IIAS career at ITESS. The inhibitory effect of the ethanolic extract was determined by the agar dilution method (Black Solis, 2017) which consisted of mixing 1mL. Of each solution and its ethanolic concentrate of C. ambriosioides, stirring each Petri dish with liquid PDA and leaving solidify. Subsequently, a sample of each strain was taken with a handle, depositing it in the middle. It was allowed to incubate in dark conditions at 27 ° C in an incubator (Memmert brand mod. IFE 400)Registro de datos. After inoculation, the diameter of the colonies was recorded, every two days (Zavala, Herrera, Lara, & Garzón, 2017), the measure was taken with a vernier and recorded in respective tables.

d) Data analysis.

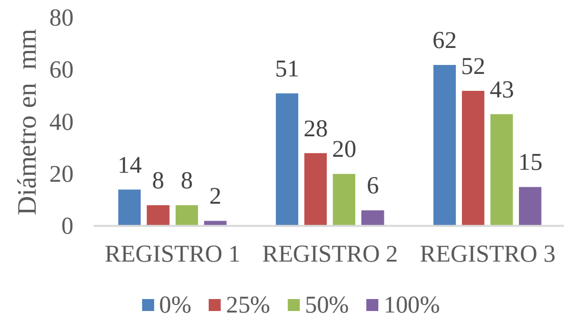
An analysis of variance (ANOVA) and multiple range comparison (Tukey) was applied applying a level of significance of 5% (Hernández-Ochoa, MacÍas-Castanãeda, Nevárez-Moorillón, Salas-Muñoz, & Sandoval-Salas, 2012). The statistical package used was the MINITAB ® version 2017 program.

Results

In vitro tests showed a greater effect of inhibition of mycelial development, with the extract concentration of 100% (Figure 1). Inhibition is observed continuously during the three epochs of the data record (Graph 1; Graph 2). the average colonial diameter was 15 mm, in contrast to the control treatment (0% crude extract concentration), with an average diameter of 62 mm and 61 mm being observed, in contrast, under the concentrations of 25% and 50%, the inhibition continues observed, (table 2), but under the last day of registration, the differences are less in magnitude.



Graphic 1 Colonial growth diameter in *F. oxysporum*



Graphic 2 Colonial growth diameter in *F. solani*

Concentration of ethanolic extract	*Fusarium oxysporum* *, **			*Fusarium solani* *, **		
	2	4	6	2	4	6
0%	14	51	62	22	43	61
25%	8	28	52	10	31	58
50%	8	20	43	10	23	38
100%	2	6	15	4	8	15
* mycelial diameter in millimeters						
* Average of three repetitions						

Table 2 Inhibition of micellar development (in mm) of Fusarium oxysporum and F. solani at four doses of epazote crude extract

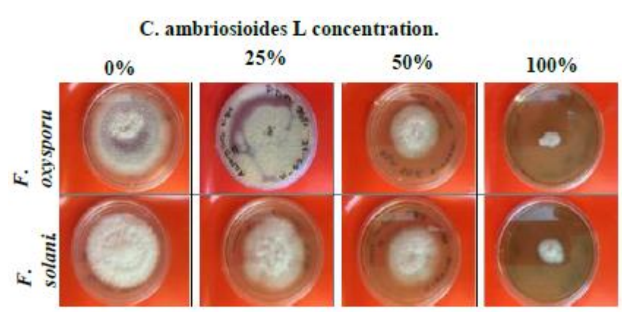


Figure 1 Inhibition of mycelial development in F. oxysporum and F. solani at four levels of ethanolic extract of C. ambriosioides

The statistical analysis showed a significant difference (p≤0.05) confirming that the 100% concentration showed the greatest effect of micellar inhibition (table 3 and table 4).

Source of the variation	GL	SC	MC	F	P
Extract Concentration	3	192.917	64.306	10.87	0.003
Error	8	47.333	5.917		
Total	11	240.25			

Table 3 Variance analysis. Inhibition of micellar development (in mm) of Fusarium oxysporum at four doses of epazote crude extract

Source of the variation	GL	SC	MC	F	P
Extract Concentration	3	516.25	172.08	9.79	0.005
Error	8	140.67	17.58		
Total	11	656.92			

Table 4 Variance analysis. Inhibition of micellar development (in mm) of Fusarium solani at four doses of epazote crude extract

Discussion

The effect of the concentration of epazote extract, is observed within each organism tested, that is, there is an inhibition in the mycelial development in F. oxysporum and F. solani, proportional to the increase in the concentration of the extract (table 3 and table 4). This same response is obtained when evaluating ethanolic extracts of dried leaves of epazote, in mature and immature state, under in vitro conditions in F. oxysporum and three other phytopathogenic fungi, the concentrations of 2000 and 3000 ppm with the mature epazote inhibited by 100 % mycelial development as well as the concentration of 3000 ppm of immature epazote extract (Cabrera Calderón et al., 2016), in this work, commercially acquired epazote leaves were used fresh, and coincides that the highest concentrations they also generated the inhibition of the fungus development as well as the decrease in sporulation, which was also observed when using aqueous extracts of C. ambriosioides at a concentration of 2% totally inhibited the development and sporulation in Fusarium oxysporum f. sp. lycopersici (FOL) and F. solani (Vazquez Covarrubias, Montes Belmont, Jiménez Pérez, & Flores-moctezuma, 2013).

Likewise, essential oils of C. ambrosioides showed an effect against Fusarium oxysporum by inhibiting the mycelial development of 97.3% at a concentration of 176.5 µL EO / L air after 72 h of exposure (Jaramillo C., Edisson Duarte, & Delgado, 2012), similar to the results of this work. Studies by Cabrera Calderón et al. (Cabrera Calderón et al., 2016) showed that at 2000 and 3000 ppm of mature and immature extract of epazote.

An inhibition of micellar development was obtained at levels greater than 75%. (Flores-Pacheco, 2017). Similarly, a reaction was demonstrated in the inhibition of micellar development in F. oxysporum using aqueous extracts of clove, cinnamon and oregano (Rueda de León et al., 2013)

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Conclusions

The results suggest that the application of C. ambriosioides extract can function as an inhibitor of the micellar growth of these fungi.

References

Aguilar-Alonso, P., Navarro-Cruz, A. R., Sanchez-Flroes, A. B., Meneses-Sánchez, M. de la C., & Avila-Sosa, R. (2013). Efecto antifúngico de extractos de plantas originarias del Estado de Puebla sobre Colletottichum gleosporoides. *CIENCIA UAT*, *7*(2), 6–11.

Aguilar, P., Navarros, A., Sanchez, B., Meneses, M., Avila, R., Gonzales, A., … Article, O. (2013). Efecto antifúngico de extractos de plantas originarias del Estado de Puebla sobre Colletotrichum gloeoporioides. *CIENCIA UAT*, *16*(3), 6–11.

Anonimo. (2011). Extract of Chenopodium ambrosioides near ambrosioides (599995) Fact Sheet.

Black Solis. (2017). Caracterización química, variabilidad composicional y modelamiento matemático del efecto de aceites esenciales en Alternaria alternata. *Revista Mexicana de Fitopatología, Mexican Journal of Phytopathology*, *35*(2), 204–226. https://doi.org/10.18781/r.mex.fit.1612-5

Black Solis, J., Ventura Aguilar, R. I., Barrera Necha, L. L., & Bautista Baños, S. (2017). Caracterización química, variabilidad composicional y modelamiento matemático del efecto de aceites esenciales en Alternaria alternata. *Revista Mexicana de Fitopatología, Mexican Journal of Phytopathology*, *35*(2), 204–226. https://doi.org/10.18781/r.mex.fit.1612-5

Cabrera Calderón, S., Rivera Rebollar, R., Lira Vargas, A., Trejo Marquez, M., & Pascual Bustamante, S. (2016). Efecto antifúngico de extracto de epazote (Chenopodium ambrosioides) sobre hongos postcosecha. *Investigación y Desarrollo En Ciencia y Tecnología de Alimentos*, *1*(2), 379–384.

Ferreira, T. M. S., Santos, J. A. do., Modesto, L. A., Souza, L. S., Santos, M. P. V. do., Bezerra, D. G., … de Paula, J. A. M. (2019). An eco-friendly method for extraction and quantification of flavonoids in Dysphania ambrosioides. *Brazilian Journal of Pharmacognosy*, *29*(2), 266–270. https://doi.org/10.1016/j.bjp.2019.01.004

Flores-Pacheco, J. A. (2017). Antagonismo in vitro de hongos endófitos para su uso en el biocontrol de enfermedades forestales. *Revista Científica de FAREM-Estelí*, (23), 58–71. https://doi.org/10.5377/farem.v0i23.5475

Forrer, H. R., Musa, T., Schwab, F., Jenny, E., Bucheli, T. D., Wettstein, F. E., & Vogelgsang, S. (2014). Fusarium head blight control and prevention of mycotoxin contamination in wheat with botanicals and tannic acid. *Toxins*, *6*(3), 830–849. https://doi.org/10.3390/toxins6030830

Hernández-Delgado, S., Ángel Reyes-López, M., Gerardo García-Olivares, J., Mayek-Pérez, N., & Reyes-Méndez, N. (n.d.). Incidencia de Hongos Potencialmente Toxígenos en Maíz (Zea mays L.) Almacenado y Cultivado en el Norte de Tamaulipas, Méxicomx. *Matamoros-Reynosa*.

Hernández-Ochoa, L., MacÍas-Castañeda, C. A., Nevárez-Moorillón, G. V., Salas-Muñoz, E., & Sandoval-Salas, F. (2012). Antimicrobial activity of chitosan-based films including spices' essential oils and functional extracts. *CYTA - Journal of Food*, *10*(2), 85–91. https://doi.org/10.1080/19476337.2011.576434

Jaramillo C., B. E., Edisson Duarte, R., & Delgado, W. (2012). Bioactividad del aceite esencial de Chenopodium ambrosioides colombiano. *Revista Cubana de Plantas Medicinales*, *17*(1), 96–97.

Jardim, C. M., Jham, G. N., Dhingra, O. D., & Freire, M. M. (2010). Chemical Composition and Antifungal Activity of the Hexane Extract of the Brazilian Chenopodium ambrosioides L. *J. Braz. Chem. Soc.*, *21*(10), 1814–1818.

Kumar, R., Mishra, A. K., Dubey, N. K., & Tripathi, B. (2007). Evaluation of Chenopodium ambriosioides oil as potential source of antifungal, antiaflatoxigenic and antioxidant activity Rajesh Kumar, Ajay Kushmar Mishra, N. K. Dubey, y. B. Tripathi International food of microbology 115 (2007) 159-164. *International Food of Microbology*, *115*, 159–164.

Mayens Vásquez-Ramírez, L., & Castaño-Zapata, J. (2017). Manejo integrado de la Marchitez por Fusarium. . . *U.D.C.A Act. & Div. Cient.*, *20(2)*, 12. Retrieved from http://www.scielo.org.co/pdf/rudca/v20n2/v20n2a14.pdf

Morales-López, G., Torres-Arteaga, I. C., E., S.-G. M., Méndez-Valencia, D., Carreño-Aguilera, G., Balzar Vera, J. C., & Ramos-García, A. (2017). Evaluación de actividad fungicida de extractos crudos de raíces de Heliopsis longipes contra Alternaria sp., Fusarium sp y Rhizopus sp. *Investigación y Desarrollo En Ciencia y Tecnología de Alimentos*, *2*, 194–198.

Morales-López, G., Torres-Arteaga, I., Salas-Galván, M. E., Méndez-Valencia, D., Carreño-Aguilera, G., Baltazar Vera, J. C., & Ramos-García, A. (2017). *Investigación y Desarrollo en Ciencia y Tecnología de Alimentos EVALUACIÓN DE ACTIVIDAD FUNGICIDA DE EXTRACTOS CRUDOS DE RAÍCES DE Heliopsis longipes CONTRA Alternaria sp, Fusarium sp Y Rizophus SP*. *2*, 194–198.

Nam, M. H., Park, M. S., Kim, H. G., & Yoo, S. J. (2009). Biological control of strawberry Fusarium wilt caused by Fusarium oxysporum f. sp. fragariae using Bacillus velezensis BS87 and RK1 formulation. *Journal of Microbiology and Biotechnology*, *19*(5), 520–524. https://doi.org/10.4014/jmb.0805.333

Potawale, S. E., Luniya, K. P., Mantri, R. A., Mehta, U. K., Sadiq, M. D., Waseem, M. D., … Deshmukh, R. S. (2008). *Chenopodium ambrosioides*: an ethnopharmacological review. *Pharmacologyonline*, *2*, 272–286.

ISSN 2444-4936

Rodriguez-Maturino, A., Troncoso-Rojas, R., Sánchez-Estrada, A., González-Mendoza, D., Ruiz-Sanchez, E., Zamora-Bustillos, R., … Aviles-Marin, M. (2015). Efecto antifúngico de extractos fenólicos y de carotenoides de chiltepín (Capsicum annum var. glabriusculum) en Alternaria alternata and Fusarium oxysporum. *Revista Argentina de Microbiologia*, *47*(1), 72–77. https://doi.org/10.1016/j.ram.2014.12.005

Rueda de León, I. C., Vargas, R. C., Muñoz, E. S., Muñoz Castellanos, L. N., & Ochoa, L. H. (2013). Actividad Antifúngica in vitro de Extractos Acuosos de Especias contra Fusarium oxysporum, Alternaria alternata, Geotrichum candidum, Trichoderma spp., Penicillum digitatum y Aspergillus niger. (Spanish). *Revista Mexicana de Fitopatología*, *31*(2), 105–112.

Shah, H., Nisar, M., Suhail, M., & Bacha, N. (2014). Antimicrobial studies of the crude extracts from the roots of Chenopodium ambrosioides Linn . *African Journal of Microbiology Research*, *8*(21), 2099–2104. https://doi.org/10.5897/AJMR2013.5548

Susana, Flores López, M. L., Benavides Mendoza, A., & Flores Olivas, A. (2011). Actividad Inhibitoria del Extracto de Heliopsis longipes Sobre Fusarium oxysporum f. sp lycopersic. *Revista Mexicana de Fitopatología*, *29*(2), 146–153. Retrieved from http://www.scielo.org.mx/scielo.php?pid=S0185-33092011000200006&script=sci_arttext&tlng=pt

Vazquez Covarrubias, D. A., Montes Belmont, R., Jiménez Pérez, A., & Flores-moctezuma, H. E. (2013). Aceites Esenciales y Extractos Acuosos para el Manejo in vitro de Fusarium oxysporum f. sp. lycopersici y F . solani. *Revista Mexicana de Fitopatología*, *31*(2), 170–179.

Vibrans, H. (2009). Chenopodiaeae. Chenopodium graveolens Willd. Retrieved July 11, 2019, from Malezas de México. website: http://www.conabio.gob.mx/malezasdemexico/chenopodiaceae/chenopodium-graveolens/fichas/ficha.htm

Zavala, R., Herrera, J., Lara, A. S., & Garzón, D. L. (2017). Evaluación de la toxicidad aguda de un extracto alcohólico de hojas de epazote (Chenopodium ambrosioides). *Spei Domus*, *12*(24). https://doi.org/10.16925/sp.v12i24.1890

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Structure, composition and tree diversity in a temperate forest under management

Estructura, composición y diversidad arbórea en un bosque templado bajo manejo

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Abstract

In order to study both diversity indices and structure of forests, which are an essential tool for decision-making in forest management, which show natural successional processes and effects for its management. So the objetive of this study was to evaluate structure and diversity of arboral species in a temperate forest of southern Jalisco state. Five permanent forestry research sites 50 x 50 (2.500 m^2) were established, and a census of all tree species was carried out, with normal diameter greater than 7.5 cm. Each individual was measured: height and normal diameter, placing an aluminum plate for identification. We obtained the importance value index (IVI), indices of diversity, richness, and dasometric parameters. There were 17 species, 9 genera and 9 botanical families; the Fagaceae was dominant. *Pinus douglasiana* presented the highest IVI (57.93%); The Shannon index had a value of 2.0; the index of Margalef was 2.4; the forest has a density of 688 trees ha-1, being the most abundant *Styrax ramirezii*; *Pinus herrerae* obtained the highest values in basal area and volume with 30.77 m^2 ha-1 and 357,325 m^3 ha-1 respectively. The values of diversity are influenced by elements of the cloud forest

Dasometric parameters, Diversity índices and Permanent plots

Resumen

El conocimiento de los índices de diversidad y estructura de los bosques, son una herramienta esencial para la toma de decisiones en el manejo forestal, que muestran procesos sucesionales naturales y efectos por su manejo. Por lo que el objetivo del estudio fue evaluar estructura y diversidad de especies arbóreas en un bosque templado del sur de Jalisco. Se establecieron cinco sitios permanentes de muestreo de 50 x 50 m (2,500 m^2), se realizó un censo de especies arbóreas con diámetro normal mayor a 7.5 cm, de cada individuo se midió altura total y diámetro normal, colocando una placa de aluminio para su identificación. Se obtuvo el índice de valor de importancia (IVI), índices de diversidad, riqueza y parámetros dasométricos. Se registraron 17 especies, 9 géneros y 9 familias botánicas; la Fagaceae fue dominante. *Pinus douglasiana* presentó el mayor IVI (57.93%); el índice de Shannon tuvo un valor de 2.0; el índice de Margalef fue de 2.4; el bosque presenta una densidad de 688 árboles ha^{-1}, siendo *Styrax ramirezii* la más abundante; *Pinus herrerae* obtuvo los mayores valores en área basal y volumen con 30.77 m^2 ha^{-1} y 357.325 m^3 ha^{-1} respectivamente. Los valores de diversidad se ven influenciados por elementos del bosque mesófilo.

Indices de diversidad, Parámetros dasométricos y Sitios permanente

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Introduction

Mexico is part of the mega diverse countries, with the largest area of primary forests in the world, the nation is located in the fourth place in species richness (SEMARNAT, 2011). It has a wooded area greater than 64.8 million hectares, of which 52% correspond to temperate forests (Challenger, 1998; CONAFOR, 2012; FAO, 2006).

Previously it was believed that forests were an inexhaustible source of resources, however, this concept has been restructuring as the loss of forest masses increases, which causes the decrease of biodiversity worldwide, which results in the temperature increase (Uribe, 2015). Forest management is a tool that allows to maintain forests and obtain goods and services that they offer.

The importance of knowing the biodiversity of ecosystems, through the indexes of diversity is fundamental in forest management, since silvicultural management practices modify or deteriorate the habitat. Changes in the structure and diversity of the forest can be generated by selective use (Corral et al., 2005).

The forests of the southeastern region of Jalisco are the most important timber in the state, these forests have been used for more than 80 years, applying various management regimes to obtain regular and irregular structures, dominating the latter with short selection. Considering the importance of forest management in this region, especially the Barranca del Calabozo ejido, five permanent forestry research sites were established, in order to assess the dynamics of the forest that allows decisions to be made within the framework of sustainable management. In this context, the objective of this research was: to evaluate the structure, composition and tree diversity in stands under management of temperate forests of southeastern Jalisco.

Methodology

The study was carried out in the El Malacate fraction of the Barranca del Calabozo ejido, in the municipality of Pihuamo, Jalisco. Geographically it is located between the extreme coordinates of 19 ° 20 '18.9 "north latitude and 103 ° 15' 24.3" west longitude.

The climate according to the Köppen classification modified by García (1987), is of type C (w2) that corresponds to a temperate, sub humid climate with rains in summer; With an average annual temperature between 18 ° C and a rainfall of 1200 mm per year (INIFAP, 2012), the soils are of the chromic Luvisol type, with great moisture retention capacity, thick thickness, with a good amount of cation exchange. (FAO UNESCO, 1990); the vegetation is formed by pine-oak forests with fractions of mountain mesophilic forest, the altitude is 2300 m.

The dasometric information was obtained from five permanent 50 x 50 m (2,500 m2) forest research sites, based on the methodology recommended by Corral et al. (2009). A woodland census was performed, registering trees with normal diameter equal to or greater than 7.5 cm; total height, in addition to all the trees an aluminum plate was placed at the height of 1.30 m, with consecutive number for identification.

To determine the tree composition, the common name and scientific name of each individual was recorded. To estimate species richness, the Margalef index (DMg) was used and for Shannon-Wiener index (H ’), using the formulas (Magurran, 2004).

$$D_{Mg} = \frac{S-1}{\ln N} \tag{1}$$

Where:
S= number of species present
ln= natural logarithm
N= total number of individuals summing all species

Shannon-Wiener index was estimated from the following expression:

$$H' = \sum pi\, ln\, pi \tag{2}$$

$$pi = \frac{ni}{N} \tag{3}$$

Where:
pi= Proportion of individuals of the species i with respect to the total number of individuals (ie the relative abundance of the species i)
ln= Natural logarithm
ni= Number of individuals of the species i.
N= Total number of individuals.

To estimate the importance value index (IVI) proposed by Curtís and Mcintosh (1951), it is defined by the equation:

IVI = Relative abundance + Relative dominance + Relative frequency

Where:

$$\text{Relative abundance} = \frac{\text{Absolute abundance for each species}}{\text{Absolute abundance of all species}} \text{ X } 100$$

$$\text{Relative dominance} = \frac{\text{Absolute basal area by species}}{\text{Absolute basal area of all species}} \text{ X } 100$$

$$\text{Relative frequency} = \frac{\text{Absolute frequency for each species}}{\text{Absolute frequency of all species}} \text{ X } 100$$

The dasometric parameters

Trees per hectare (density): number of trees registered at the sampling sites and inferred to the hectare. The basal area by species was determined with the following formula:

$$G = \frac{\pi * DN^2}{4}$$

Where:

G= Basal area (m²).
π= (pi) The ratio between the circumference and the diameter of a circle.
DN= Normal diameter at height (1.30m)

To estimate the total volume per tree, of the genus Pinus and Quercus, the models generated for the Forest Management Unit (UMAFOR) 1404 "Cd Guzmán" were used, in the CONACYT-CONAFOR agreement (2013). For the species considered other leafy or other broadleaved species, the models used in the Comprehensive Management Program of the Atenquique Region (Table 1) were used.

Species	Model
Pinus douglasiana	$vtacc = 0.0000378 * d^{1.917183} * h^{1.0826524} + 0.0000813 * d^2$
Pinus devoniana	$vtacc = 0.0000478 * d^{2.1064443} * h^{0.800508} + 0.0001054 * d^2$
Pinus herrerae	$vtacc = 0.0000654 * d^{1.9920841} * h^{0.8413872} + 0.0000714 * d^2$
Pinus oocarpa	$vtacc = 0.0000538 * d^{2.0733857} * h^{0.7998558} + 0.0000895 * d^2$
Quercus candicans	$vtacc = 0.0000765 * d^{1.8181666} * h^{0.9334637} + 0.0002233 * d^2$
Quercus crassifolia	$vtacc = 0.0000337 * d^{1.9711755} * h^{1.0224766} + 0.0002726 * d^2$
Quercus castanea	$vtacc = 0.00006682 * d^{1.868929} * h^{0.91262} + 0.0003244 * d^2$
Quercus rugosa	$vtacc = 0.0000381 * d^{1.9415088} * h^{1.0189592} + 0.0002529 * d^2$
Quercus obtusata	$vtacc = 0.0000218 * d^{1.9324875} * h^{1.2333404} + 0.0002094 * d^2$
Quercus laurina	$vtacc = 0.0000381 * d^{1.9415088} * h^{1.0189592} + 0.0002529 * d^2$
Styrax ramirezii	Ln (vtacc) = -11.162 + 2.417212 * Ln (d) + 0.835947 * Ln(h)
Arbutus xalapensis	Ln (vtacc) = -11.162 + 2.417212 * Ln (d) + 0.835947 * Ln(h)
Clethra lanata	Ln (vtacc) = -11.162 + 2.417212 * Ln (d) + 0.835947 * Ln(h)
Podocarpus matudae	Ln (vtacc) = -11.162 + 2.417212 * Ln (d) + 0.835947 * Ln(h)
Ternstroemia sp.	Ln (vtacc) = -11.162 + 2.417212 * Ln (d) + 0.835947 * Ln(h)
Crataegus mexicana	Ln (vtacc) = -11.162 + 2.417212 * Ln (d) + 0.835947 * Ln(h)
Carpinus caroliniana	Ln (vtacc) = -11.162 + 2.417212 * Ln (d) + 0.835947 * Ln(h)

Tabla1 Mathematical models to estimate volumes per tree, where vtacc = total volume tree with bark, d = normal diameter and h = total height

Results and Discussion

Floristic composition

The floristic composition of the tree stratum is represented by pine-oak forests and a portion of mesophilic mountain forest. 17 species, 9 genera, 9 families and five orders were registered. The best represented families were: Fagaceae with six species, followed by the Pinaceae family with four species (Table 2).

Species	Family	Order
Arbutus xalapensis Kunth	Ericaceae	Ericales
Carpinus caroliniana Walter	Betulaceae	Fagales
Clethra lanata M. Martens & Galeotti	Clethraceae	Fagales
Crataegus mexicana Loudon	Rosaceae	Rosales
Quercus candicans Née	Fagaceae	Fagales
Q. castanea Née	Fagaceae	Fagales
Q. crassifolia Bonpl.	Fagaceae	Fagales
Q. obtusata Bonpl.	Fagaceae	Fagales
Q. laurina Humb. Et Bonpl	Fagaceae	Fagales
Q. rugosa Née	Fagaceae	Fagales
Pinus devoniana Lindl.	Pinaceae	Pinales
Pinus douglasiana Martínez	Pinaceae	Pinales
Pinus herrerae Martínez	Pinaceae	Pinales
Pinus oocarpa Schiede ex Schtdl.	Pinaceae	Pinales
Podocarpus matudae Lundell	Podocarpaceae	Ericales
Styrax ramirezii Greenm.	Styracaceae	Ericales
Ternstroemia sp.	Penthaphylacaceae	Ericales

Table 2 Tree species present in the study area

Unlike what was reported by Graciano-Ávila et al. (2017), Those who studied an area of 2.50 ha, in a pine and pine-oak forest in the state of Durango, where they pointed to the Pinaceae family with a greater number of species (five), it should also be noted that although in our case it was a smaller sampled area (1.25 ha), a greater diversity of species was obtained with 17 against 13, represented in nine families against five, reported in the study cited and was even greater than that indicated by López-Hernández et al . (2017) in Puebla with only 11 species in five genera.

Figure 1 shows the distribution of trees by species; the total density was 860 individuals, distributed in 17 species; Styrax ramirezii (200 trees), Pinus douglasiana (186 trees), P. herrerae (180 trees) and Quercus candicans (124 trees) were the ones with the highest density, the rest (170 trees) complements the total. Carpinus caroliniana (1 tree) and Podocarpus matudae (15 trees), are listed within NOM-059-SEMARNAT-2010, threatened (A) and with special protection (Pr), respectively.

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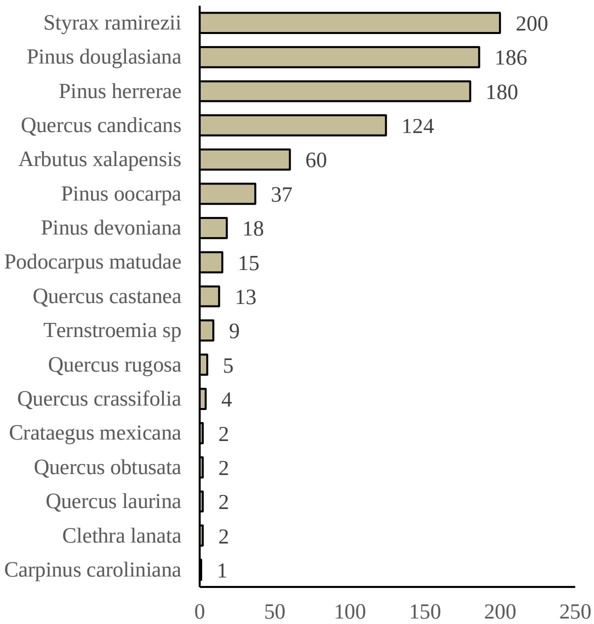


Graphic 1 Número de árboles por especie

Diversity

The species richness index of Margalef (DMg) was 2.4, higher than that reported by Návar and González (2009) of 1.04, in Durango forests and by Hernández et al. (2013) in temperate forests of Chihuahua of 0.9. The Shannon-Wiener (H ’) diversity index was 2.0; This diversity value is greater than that reported by García et al (2012) in forests in the Sierra Madre Oriental of the state of Nuevo León, and by Hernández et al (2013), in temperate forests of Chihuahua with 0.34.

Importance Value Index

Abundance

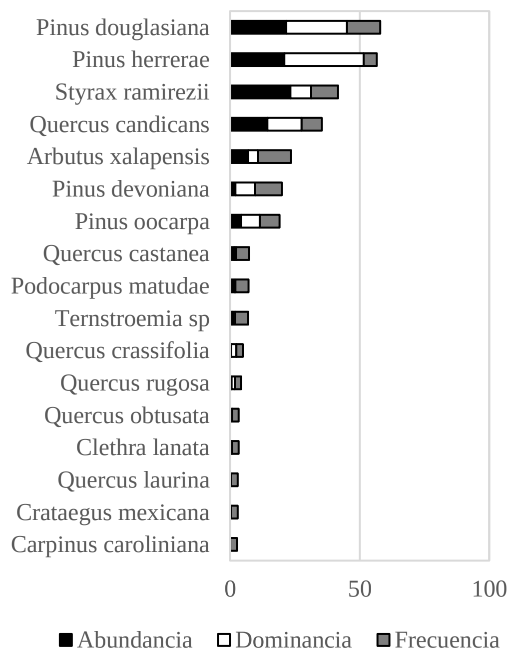
The most abundant species were: Styrax ramirezii with 200 trees, which represented 23.26% of the total; followed by Pinus douglasiana (186 trees), which represent 21.63% and P. herrerae (180 trees) with 20.93% of the total.

Dominance

The total basal area was 30.77 m², where the most dominant species were: Pinus herrerae (11.75 m²) representing 30.55% of the total species, followed by P. douglasiana (9.03) with 23.48%. The two species make up 43.03% of the total of 17 species found.

Frequency

The most frequent species are Pinus douglasiana and Arbutus xalapensis (they occur in all sampling sites) with a frequency of 12.82%, followed by Styrax ramirezii and Pinus devoniana with 10.26%, the other species have lower values. The species with the highest importance value index (IVI) was P. douglasiana (57.93%), P. herrerae (56.61%) and Styrax ramirezii (42.88%), were the most outstanding spices having the highest values, the species more rare, with less value was Carpinus caroliniana with 0.90%. (Graphic 2, Table 3). Graciano-Avila et.al. (2013) report that P. cooperi (79.05%) and P. durangensis (70.89%) had the highest IVI values, these species were the most important in forests of the La Victoria de Durango ejido.



Graphic 2 Importance Value Index (IVI)

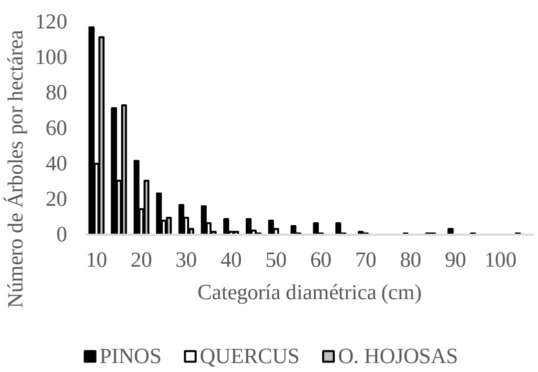
Species	Abundance		Dominance		Frequency		IVI
	Abs.	Rel (%)	Abs.	Rel (%)	Abs.	Rel (%)	
Pinus douglasiana	186	21.63	9.03	23.48	5	12.82	57.93
Pinus herrerae	180	20.93	11.75	30.55	2	5.13	56.61
Styrax ramirezii	200	23.26	3.11	8.09	4	10.26	42.88
Quercus candicans	124	14.42	5.08	13.21	3	7.69	39.17
Arbutus xalapensis	60	6.98	1.41	3.68	5	12.82	21.23
Pinus devoniana	18	2.09	2.91	7.57	4	10.26	18.31
Pinus oocarpa	37	4.3	2.75	7.15	3	7.69	18.18
Quercus castanea	13	1.51	0.29	0.76	2	5.13	7.08
Podocarpus matudae	15	1.74	0.11	0.28	2	5.13	1.53
Ternstroemia sp	9	1.05	0.34	0.87	2	5.13	1.50
Quercus crassifolia	4	0.47	0.74	1.91	2	5.13	7.08
Quercus rugosa	5	0.58	0.46	1.19	1	2.56	1.45
Quercus obtusata	2	0.23	0.21	0.54	1	2.56	1.11
Clethra lanata	2	0.23	0.19	0.48	1	2.56	1.95
Quercus laurina	2	0.23	0.05	0.13	1	2.56	0.98
Crataegus mexicana	2	0.23	0.03	0.08	1	2.56	0.96
Carpinus caroliniana	1	0.12	0.01	0.03	1	2.56	0.90
Total	**860**	**100**	**38.47**	**100**	**39**	**100**	**300**

Table 3 Abundance, dominance, frequency and Importance Value Index of the species (sorted in descending order according to their IVI)

Dasometric Parameters

Individuals by diametric category

Individuals by diametric category the horizontal structure shows an irregular, incoethane structure in the form of an inverted "J" (Liocourt curve). The largest number of individuals correspond to the smaller categories, between 10 and 15 cm in normal diameter, with few individuals larger than 70 cm. The group of other leaflets as a whole has smaller diameters, not larger than 40 DN, while the group of the genus Pinus showed the largest diameters with records of 90 to 105 cm DN (Graphic 3). Juarez et al. (2014) analyzed the silvicultural structure of a temperate forest in Tamaulipas, Mexico, reporting the largest number of trees in diametric categories between 10 and 20 cm of the Quercus and Pinus genera, similar to those obtained in the present study.



Graphic 3 Diameter distribution

Species	Arb/ha	AB/ha (m^2)	Vol/ha (m^3)	Altura media (m)	DN Medio (cm)
Pinus devoniana	14.4	2.3284	32.311	21.44	41.25
Pinus douglasiana	148.8	7.2266	81.342	15.47	20.58
Pinus herrerae	144.0	9.4016	141.680	16.10	21.58
Pinus oocarpa	29.6	2.1995	24.572	16.75	27.93
Quercus candicans	99.2	4.0653	41.412	12.08	19.19
Quercus castanea	10.4	0.2337	2.176	8.31	15.25
Quercus crassifolia	3.2	0.5888	4.895	12.13	47.81
Quercus laurina	1.6	0.0404	0.411	11.95	16.43
Quercus obtusata	1.6	0.1669	1.463	14.40	35.90
Quercus rugosa	4.0	0.3669	3.165	12.18	33.54
Arbutus xalapensis	48.0	1.1310	6.756	9.98	15.93
Carpinus caroliniana	0.8	0.0089	0.039	13.00	11.90
Clethra lanata	1.6	0.1480	1.285	17.40	33.05
Crataegus mexicana	1.6	0.0245	0.088	8.75	13.45
Podocarpus matudae	12.0	0.0858	0.269	9.25	9.44
Styrax ramirezii	160.0	2.4898	13.904	13.29	13.25
Ternstroemia sp	7.2	0.2692	1.557	12.40	19.06
Total	688.0	30.7754	357.325		

Table 4. *Dasometric parameters*

Trees per hectare

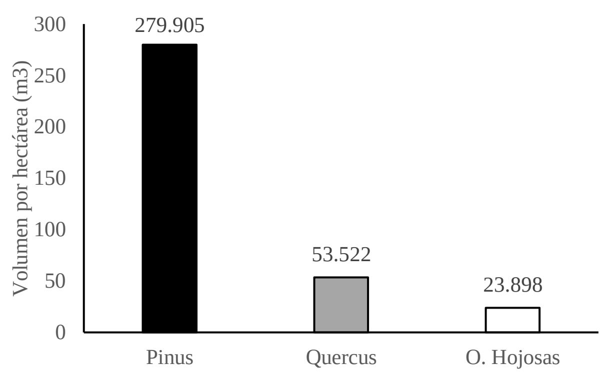
The density expressed in number of trees per hectare was 688; the species that presented the greatest amount were: Styrax ramirezii, Pinus douglasiana and P. herrerae with 160, 148.8 and 144 ha^{-1} trees, the rest (235.2 ha^{-1} trees) are made up of the other 13 species. The density of 688 ha-1 trees can be considered high, compared to that obtained by Martínez, et al (2012). In permanent research sites "El Poleo" Madera, in Chihuahua, where they report values from 348,404 to 1,272 ha^{-1} trees, the latter mostly corresponds to young trees.

Basal area per hectare

In the case of the total basal area per hectare, it was 30,775 m^2; the highest values corresponded to the genus Pinus with 21,156 m2 ha^{-1}, followed by the genus Quercus with 5,462 m^2 ha-1 and other leafy with 4,157 m2 ha-1. The values of the basal area are similar to those reported by Martínez, et al. (2012), where it reports values from 22.1 to 30.6 m2 ha^{-1}.

Volume per hectare

For the determination of the volume, the absolute values of the five sampling sites were used and subsequently the inference was made for one hectare. The total volume per hectare grouping all trees was 357,325 m^3 (total tree volume); the Pinus had the highest volumes with 279,905 m3 ha^{-1}, followed by the genus Quercus with 53,522 m^3 ha^{-1} and the other leafy with 23,898 m3. ha^{-1} (Graphic 4)



Graphic 4 Volume per hectare by gender and group of species

Martínez, et al. (2012), reported volumes from 88.6 to 261.7 m3. ha-1 and Reyes et al. (2016) in Durango forests, they indicated total real stocks, inferred to the hectare of up to 198,625 m3.

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In both cases the volumes are lower than those obtained in the present study, which indicates that the stands where the sampling sites were located have good site quality, that is, they are areas with good timber production.

Conclusions

The tree floristic composition is represented by 17 species, 9 genera, grouped into 9 families and 5 orders. The best represented botanical family was Fagaceae.

The specific wealth of the studied community was 17 species, with a Margalef index (D_{mg}) of 2.4; in relation to the value of diversity, the Shannon-Wiener index (H') was 2.0. Apparently, the diversity values were influenced by elements of the mountain mesophilic forest.

The importance value index (IVI) indicates that P. douglasiana (57.93%), P. herrerae (56.61%) and Styrax ramirezii (42.88%), were the most outstanding spices having the highest values.

The volume per hectare of all species was 357,325 m^3 ha^{-1}; the highest volume corresponded to the genus Pinus (279,905 m^3. ha^{-1}), followed by the genus Quercus (53,522 m3. ha^{-1}) and with the lowest volumes for the other leafy (23,898 m3. ha^{-1}). P. herrerae, was the species with the highest volume with 141,680 m^3. ha^{-1}

The stands where the sampling sites were located presented a good site quality, that is, they are areas with good timber production.

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References

Challenger, A. 1998. Utilización y conservación de los ecosistemas terrestres de México, pasado, presente y futuro de México, CONABIO, Instituto de Biología, UNAM, Agrupación Sierra Madre, S.C.P., 847 p.

Clifford, H.T. y Stephenson, W. 1975. An introduction to numerical classification. Academic Press, London. 350 pp.

CONAFOR (Comisión Nacional Forestal). 2012. Inventario Nacional Forestal y de Suelos, informe del 2004-2009 (1a. ed). Zapopan, Jalisco, México: CONAFOR. 22 p.

CONAFOR-CONACYT. 2013. SiBiFor Biblioteca digital del sistema biométrico para la planeación del manejo forestal sustentable de los ecosistemas con potencial maderable en México. http://fcfposgrado.ujed.mx/sibifor/inicio/buscar.php?a=volumen%20total0arbol#,

Corral-Rivas, J. J.; Aguirre, O.; Jiménez, J. y Corral, S. 2005. Un análisis del efecto del aprovechamiento forestal sobre la diversidad estructural en el Bosque Mesófilo de Montaña "El Cielo", Tamaulipas, México. Investigaciones Agrarias: Sistemas de Recursos Forestales, 14 (2), 217-228.

Corral-Rivas, J. J.; Vargas, L.B.; Wehekel, C.; Aguirre, C. O.; Álvarez, G. J. y Rojo, A.A. 2009. Guía para el Establecimiento de Sitios de Investigación Forestal y de Suelos en Bosques del Estado de Durango. Editorial UJED. Durango. 81p.

Curtis J.y Mcintosh R. 1951. An upland forest continuum in the pariré-forest border región of Wisconsin. Ecology 32: 476-496 p.

FAO. 2006. Tendencias y perspectivas del sector forestal en America Latina y el Caribe. Roma 60: 100 p.

FAO-UNESCO. 1990. Mapa mundial de suelos. Informes sobre recursos mundiales de suelos. Organización de las Naciones Unidas para la Agricultura y la Alimentación. Roma. 60: 142 p.

García., E. 1987. Modificaciones al sistema de clasificación climática de Köppen. Instituto de Geografía, UNAM. México. 246 p.

González E. S.; González, E. M. y Cortez O. A. 1993. Vegetación de la reserva de la biosfera “La Michilia”, Durango, México. Acta Botánica Mexicana, 22, 1-104.

Graciano, A.G.; Aguirre, C.O.A.; Alanis R.E. y Lujan S.J.E 2017. Composición, estructura y diversidad de especies arbóreas en un bosque templado del noroeste de México. Ecosistemas y Recursos Agropecuarios, 4(12), 535-542. doi: 10.19136/era. a4n12.1114

Hernández, J.; Aguirre, O.; Alanís, E.; Jiménez, J. y González, M. A. 2013. Efecto del manejo forestal en la diversidad y composición arbórea de un bosque templado del noroeste de México. Revista Chapingo serie Ciencias Forestales y del Ambiente, 19 (3), 189-199. http://www.redalyc.org/pdf/617/61750015003.pdf

INIFAP (Instituto Nacional de Investigaciones forestales, Agrícolas y Pecuarias). 2012. Estadísticas Climáticas Normales del Estado de Jalisco. Centro de Investigación Regional Pacífico Centro. Libro Técnico No. 2. Jalisco. 132 p.

Juárez, S.M.; Domínguez C.P. y Návar CH.J. 2014. Análisis de la estructura silvícola en bosques de la Sierra de San Carlos, Tamaulipas, México. Foresta Veracruzana 16(1):25-34.

López, H. J.A.; Aguirre, C.O.A.; Alanís, R. E; Monárrez, G. J.C.; González, T.M. y Jiménez, P. J. (2017). Composición y diversidad de especies forestales en bosques templados de Puebla, México. Madera y Bosques, 23(1), 39-51. doi:10.21829/myb.2017.2311518

Magurran, A.E.2004. Measuring biological diversity. Blackwell. Cambridge, USA. 256 p http://silvicultoresdejalisco.org.mx/wp-content/uploads/2017/05/Memoria-del-Estudio-Regional-Forestal-1404.pdf

Martínez, S.M.; Pérez, S.G.; Gándara, V.G.A.; Hernández, L.A., González, M.C.J.; Armendáriz, O.R.; Chacón, S.M.J.; Moreno, G.A. y Meléndez, O.M.C. 2012. Estado actual del conocimiento de sitios permanentes de investigación silvícola (SPIS) en el estado de Chihuahua. SAGARPA-INIFAP. 125 p.https://brioagropecuario.com/index.php/2017/06/30/estado-actual-del-conocimiento-de-sitios-permanentes-de-investigacion-silvicola-spis-en-el-estado-de-chihuahua/

Návar, C. J.J., y González, G. S. 2009. Diversidad, estructura y productividad de bosques templados de Durango, México. Polibotanica, 28, 71-87. Obtenido de http://www.scielo.org.mx/pdf/polib/n27/n27a5.pdf

Reyes, M. J. L.; Bretado, V. J. L.; Loera, G. M. H.; Simental, C.A.J.; Castillo, O. I.; Moreno, S. R.; Antuna, M. E. y Soto, M. A. 2016). Evaluación de existencias volumétricas conforme a la legislación forestal vigente en México. AGROFAZ, 16 (1) 77-83.

SEMARNAT (Secretaría de Medio Ambiente y Recursos Naturales). 2011. Anuario Estadístico de la Producción Forestal. 228 p.

URIBE, E. 2015. El cambio climático y sus efectos en la biodiversidad en América Latina. Santiago de Chile. Comisión Económica para América Latina y el Caribe (CEPAL). 84p.

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Floristic composition in deciduous tropical forest to west of Irapuato, Guanajuato

Composición florística del Bosque tropical caducifolio al oeste de Irapuato, Guanajuato

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Abstract

The flora of Irapuato has been poorly explored, because it is an area dedicated to agriculture and there are few strains of tropical deciduous forest and subtropical scrubland. The objectives of the study were to know the floristic composition in Cerro del Veinte, compare the richness of species with other locations that have the same type of vegetation and determine the conservation status of the species according to NOM-059 SEMARNAT-2010. The sampling was through free transects of approximately 1 km in the Barrancas La Escondida and El Paiste. A total of 59 families, 137 genera, 171 species and four varieties were obtained. The best represented families are Asteraceae, Fabaceae and Pteridaceae. According to the Chao 2 estimator, the sampling effort in the study area was 87%. Floristic affinity in Cerro del Veinte was greater with the Hoya de Rincón de Parangueo (38%) and Sierra de Pénjamo (32%). In addition, there are three new species reported for Guanajuato, *Govenia lagenophora* and *Sacoila lanceolata* (Orchidaceae) and *Solanum edmundoi* (Solanaceae). The taxa *Cedrela odorata* and *Erythrina coralloides* are included in NOM-059-SEMARNAT-2010.

Cerro del Veinte, Chao 2 estimator, Orchidaceae

Resumen

La flora de Irapuato ha sido poco explorada, debido a que es un área dedicada principalmente a la agricultura y quedan pocos manchones de bosque tropical caducifolio y matorral subtropical. Los objetivos del estudio fueron conocer la composición florística en el Cerro del Veinte, comparar la riqueza de especies con otras localidades que presentan el mismo tipo de vegetación y determinar el estado de conservación de las especies de acuerdo a la NOM-059 SEMARNAT-2010. El muestreo fue por medio de transectos libres de aproximadamente 1 km en las Barrancas La Escondida y El Paiste. Se obtuvo en total 59 familias, 137 géneros, 171 especies y cuatro variedades. Las familias mejor representadas son Asteraceae, Fabaceae y Pteridaceae. De acuerdo al estimador Chao 2 el esfuerzo de muestreo en el área de estudio fue de 87 %. La afinidad florística en el Cerro del Veinte fue mayor con la Hoya de Rincón de Parangueo (38%) y Sierra de Pénjamo (32%). Además, se tienen tres nuevas especies reportadas para Guanajuato, *Govenia lagenophora* y *Sacoila lanceolata* (Orchidaceae) y *Solanum edmundoi* (Solanaceae). Y los taxones *Cedrela odorata* y *Erythrina coralloides* están incluidas en la NOM-059-SEMARNAT-2010.

Cerro del Veinte, Estimador Chao 2, Orchidaceae

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Introduction

Mexico is a country with great floristic diversity with a record of 23 314 species of vascular plants (Villaseñor, 2016), also presents different types of vegetation throughout its territory, one of these communities is the tropical deciduous forest (BTC) or Low deciduous forest (Rzedowski, 2006). The tropical deciduous forest is characterized by having a very diverse flora and approximately 60% of its elements are endemic. The distribution of the forest in the Bajío region has a semi-warm climate with the lowest minimum temperature of 6ºC and altitudes above 1700 meters above sea level (Trejo-Vázquez, 1999). The BTC on flat land has disappeared due to the ease of access to establish cultivation areas or agostaderos, causing fragmentation of isolated locations that are currently part of secondary vegetation (Zamudio, 2012).

In the state of Guanajuato, the BTC originally occupied large areas, to the south in the biogeographic province that corresponds to the Neovolcanic Axis where it mainly covered hillsides and ravines; but in the last 20 years its extension has decreased, due to agriculture and logging; Currently, there is a record of less than 10% of the total area of the state, and there are only fragments in isolated locations or becoming secondary vegetation such as subtropical scrubland (Rzedowski and Calderón de Rzedowski, 1987; Zamudio, 2012).

Another factor that has influenced the loss of the BTC is the immoderated logging of some timber species used in construction, such as poles and fuels (Rzedowski, 2006).

The floristic components of the tropical deciduous forest are variable depending on each zone and even this plant community in the country is scarcely similar in its flora (Rzedowski and Calderón de Rzedowski, 2013). The presence or absence of some floristic elements depends on environmental factors such as temperature, humidity and precipitation, in addition these forests generally do not have a dominant species because they are very diverse.

In Guanajuato it is common to find tree species such as Lysiloma microphylla (stick prieto), Albizia plurijuga (white stick), Bursera cuneata (copal), Ceiba aesculifolia (ceiba or pochote), Ipomoea murucoides (huntress), Vachellia farnesiana and V. schaffneri (huizache), V. pennatula (tepame), Bursera fagaroides (cuajiote or copal), Opuntia streptacantha (nopal cardón), Heliocarpus terebinthinaceus, Myrtillocactus geometrizans (garambullo), Agonandra racemosa, Eysenhardtia polystachya (sweet stick), coral stick) Senna polyantha, Parkinsonia aculeata (reed), Prosopis laevigata (mesquite), Casimiroa edulis (white sapote). And shrub species such as Calliandra humilis, Condalia velutina, Senna floribunda, Mimosa aculeaticarpa and Verbesina sphaerocephala (Rzedowski, 2006; Zamudio, 2012). In Guanajuato and in other states there is no dominant species in the BTC, but the presence and abundance of Fabaceae family species that has persisted and evolved in these environments is evident (Hernández-Ramírez and García-Méndez, 2015).

The vascular flora in the state of Guanajuato is estimated at 3,206 species, of which 3032 are flowering plants, 150 lycopods and ferns and 24 gymnosperms and only seven taxa are reported as endemic in the entity (Villaseñor, 2016).

The floristic studies in the municipality of Irapuato are few, López and Martínez (2009) in the ANP Cerro de Arandas recorded a list of 22 taxa, the dominant species being Vachelia farnesiana and Ipomoea murucoides and Hernández-Hernández et al., (2017) 30 species of lycopodia and ferns report in Tamahula, Cerro del Veinte.

The objectives of the present study were to obtain the floristic list in two canyons of Cerro del Veinte to establish a comparison with other localities of Guanajuato that present the same type of vegetation (BTC) and also determine if any of the species is in some criterion of conservation according to NOM-059- SEMARNAT-2010 (SEMARNAT, 2010).

Study area

The Cerro del Veinte is located in the western portion of the municipality of Irapuato and northeast of Abasolo, occupies an area of approximately 6120.52 ha (INEGI, 2015).

The study covered two ravines located in the community of Cuchicuato, Irapuato, 1) Barranca la Escondida is located south of the hill at 20 ° 41´ 26.6´´ N and 101 ° 30´ 18.6´´ W, at an altitude range between 1815 to 2023 meters above sea level and 2) Barranca el Paiste is located east of the hill at 20 ° 41´ 49.47´´ N and 101 ° 30´ 18.0´´ W, at 1866 to 2094 meters above sea level (Figure 1).

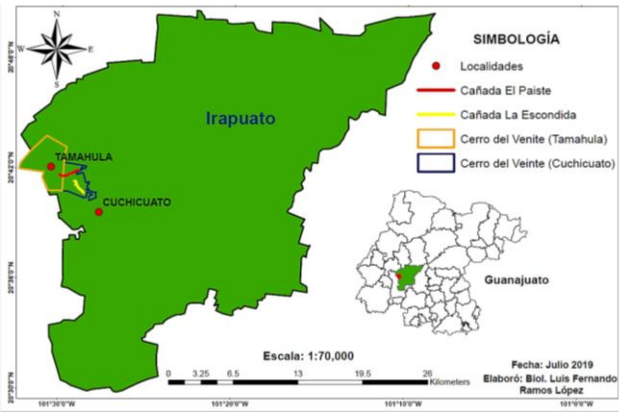

Figure 1 Geographical location of Cerro del Veinte, Irapuato, Gto.

It has a sub-humid semi-warm climate, with an annual average cumulative precipitation of 688 mm, the rainiest month is August with 160 to 170 mm and the one with the lowest rainfall is February with 5 mm. The average annual temperature is 18.7 ° C, the warmest month is May with 28 ° C and the coldest January with 16 ° C (INEGI, 2015).

The municipality of Irapuato is part of the Lerma River basin (hydrological region 12), which in turn is divided into three sub-basins, 1) Guanajuato, 2) Temacatío and 3) Pénjamo - Irapuato-Silao; This last sub-basin is where the study area is located (Cruz-José et al., 2012).

The type of soil present in the hill is vertisol, they are shallow soils of 50 cm, shallow and stony brown to black, clayey texture with moisture retention capacity and low organic matter (Quijano-Carranza et al., 2012).

Methodology

The collection of vascular plants was carried out during the period from February 2015 to January 2016, both in the rainy and dry season; the sampling was by the method of free transects of approximately one kilometer (Mostacedo and Fredericksen, 2000) in the two canyons of Cerro del Veinte.

The identification of the plants was with the help of specialized literature and field guides (Rzedowski and Guevara-Féfer, 1992; Mickel and Smith, 2004; Calderón de Rzedowski and Rzedowski, 2004; Cretcher et al., 2010; Sahagún-Godínez et al., 2014). Herbalized material was deposited in the collection of the Higher Technological Institute of Irapuato.

Statistic analysis

The sampling effort was measured by means of species accumulation curves, based on random sampling. Species richness was calculated using the Chao 2 diversity estimator (Jiménez-Valverde and Hortal; 2003), in the EstimateS 9.1.0 program (Colwell, 2013).

The Sϕrensen Similarity Index was applied to estimate the number of shared species, with four locations in Guanajuato, the criterion was that the localities presented tropical deciduous forest, and thus determine the similarity between sites based on the number of related species (Moreno , 2001).

Results

A total of 319 specimens of vascular plants corresponding to 59 families, 137 genera, 171 species and 4 varieties were reviewed. The families with the highest number of species are Asteraceae (20), Fabaceae (16) and Pteridaceae (14). The largest number of species corresponds to the herbaceous stratum as elements of the undergrowth, the tree stratum with 20 species that constitutes the major part of the vegetation cover and vines with 11 taxa (Annex 1).

The species included in NOM-059-SEMARNAT-2010 are Cedrela odorata subject to special protection and Erythrina coralloides as threatened.

Some rare species that are found only once on the hill, are Dichromanthus cinnabarinus, Govenia lagenophora and Sacoila lanceolata belonging to the Orchidaceae family; Jarilla caudata is an edible plant in the study area; other scarce taxa are Pavonia candida and Solanum edmundoi and some Bursera penicillata, Colubrina triflora and Manihot caudata trees.

The Chao 2 estimator predicts 212 species (with 95% completeness) and so far 87% of the flora in the Cerro canyons has been inventoried with the observed wealth of 175 taxa (Fig. 2).

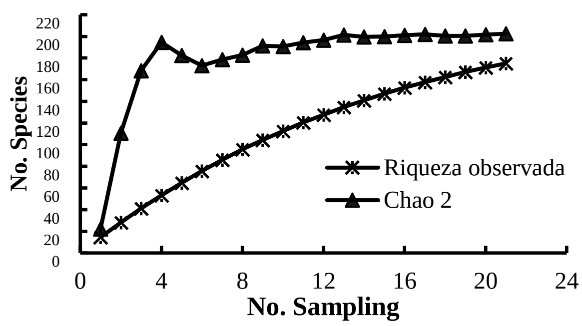

Figure 2 Accumulation curve of species present in the El Paiste and La Escondida Canyon of Cerro del Veinte

The floristic similarity of the BTC in the Cerro del Veinte and other towns of Guanajuato was greater with Hoya de Rincón de Parangueo (38%) and Sierra de Pénjamo (32%) and less with Cerro de Arandas and San José de Iturbide (Table 2).

Table 2. Floristic comparison between communities with tropical deciduous forest in Guanajuato. In parentheses the total number of species of each shared area / taxa and altitude is presented.

Locations	Hill of Twenty (175 spp.) 1974-2036 m. Similarity percentage
Cerro de Arandas, Irapuato (22/11 spp.), 2000 m	11.6
Hoya Rincon de Parangueo (228/77 spp.), 1850 m	38
Sierra de Pénjamo (258/74 spp.), 1783-1950 m	34
San Jose Iturbide (69/10 spp.), 2100-2500 m	8

Discussion

The tropical deciduous forest is characterized by presenting great floristic diversity; however, at a specific level there is no complete estimate of the species that inhabit these Forests, but there is a report of 749 genera of phanerogams of which 96 are dominant and frequently grow in Mexico (Rzedowsky and Calderón de Rzedowsky, 2013) , for the hill of Twenty there is a total of 124 genera that is 16.55% of those recognized in the country and the dominant and similar genera corresponds to 16.66%;

Trejo-Vázquez (1999) mentions the low floristic similarity of the BTC between the different entities of the Mexican Republic.

In the Bajío Guanajuatense region, the BTC is regularly distributed in cerrile portions and at altitudes greater than 1800 meters above sea level (Trejo-Vázquez, 1998), Cerro del Veinte presents these conditions, that is, it is an area with steep slopes and is located between 1974 to 2036 masl.

The families of angiosperms important for their abundance in the BTC are Asteraceae, Fabaceae, Malvaceae, Acanthaceae, Cucurbitaceae, Malpighiaceae, Euphorbiaceae and Sapindaceae (Rzedowski and Calderón de Rzedowsky, 2013), in the Hill the best represented families are Asteraceae (20 spp.) and Fabaceae (16 spp.) with the highest number of species, in Acanthaceae and Euphorbiaceae there are 6 species and the remaining families with only two taxa; Aguilera (1991) in the crater Hoya de Rincón de Parangueo also reported 22 species of Asteraceae and in Fabaceae 23.

Another relevant group, although scarcely diverse in the BTC are lycopodia and ferns, in the Sierra de Pénjamo 37 species were found and the representative family is Pteridaceae with 16 (Hernández-Hernández et al., 2016), this family was also abundant in The work area with 14 taxa. The species included in NOM-059-SEMARNAT-2010 are Cedrela odorata in the category subject to special protection and Erythrina coralloides as threatened.

On the other hand, Manihot caudata is a rare species in the shoal (Aguilera, 1991) and Bursera penicillata is in danger of disappearance in the shoal (Rzedowski and Guevara-Féfer, 1992). The species Govenia lagenophora and Sacoila lanceolata belong to the Orchidaceae family and are new records for the state of Guanajuato, it had not been inventoried in the literature (Zamudio and Galván-Villanueva, 2011; Villaseñor, 2016), these orchids are of terrestrial habit and Very few in the BTC, they usually grow in places with favorable atmospheric humidity, at higher altitudes as is the case in the study area and are also considered as sensitive to disturbance (Rzedowsky and Calderón de Rzedowsky, 2013).

Taking into account these abiotic factors, it can be affirmed that the state of conservation in the El Paiste ravine of Cerro del Veinte is suitable for the establishment of these orchids, on the other hand in the La Escondida ravine, the Dichromanthus cinnabarinus orchid was already registered with Priority in the state (Zamudio and Galván-Villanueva, 2011).

The species Solanum edmundoi (Solanaceae) was recently reported for Mexico, the type specimen described comes from the Sierra de Cacoma, Jalisco (Cuevas-Guzmán and Núñez-López; 2015; Villaseñor, 2016), and had not been found in Guanajuato and grows in the El Paiste ravine in a preserved area. According to the Chao 2 estimator, the sampling effort was appropriate on the hill of Twenty, 87% was inventoried and 37 species would be missing to reach the asymptote.

The similarity in the composition and richness of BTC species in Cerro del Veinte compared to the four areas of Guanajuato, had greater affinity with the Sierra de Pénjamo by sharing 74 species (Guadián-Marín, 2012) and the Hoya de Rincón de Parangueo with 77 taxa (Aguilera, 1991) and was smaller with San José de Iturbide with only 10 species in common (Gutiérrez and Solano, 2014), in the Guanajuatense basin this vegetable community is distributed between 1700 to 2000 m, within higher altitude areas in the Mexican Republic (Rzedowski and Calderón de Rzedowski, 1987). In addition, the floristic composition of the BTC usually differs mainly due to abiotic factors such as climate, altitude and geographical arrangement of each region and the floristic affinity of most BTC taxa are of Neotropical origin (Trejo-Vázquez, 1999).

Conclusion

The floristic diversity of the BTC in the Cerro del Veinte consists of 175 taxa of vascular plants, where conservation indicator species such as terrestrial orchids are still growing. According to the Chao 2 estimator, 13% of the vascular flora in the hill remains to be collected, so it is recommended to continue with the botanical exploration.

This study is a contribution to floristic knowledge in Irapuato, Guanajuato and could serve as a basis for proposing the area in conservation programs, being a relict of BTC in the municipality.

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References

Aguilera, G. L. I. (1991). Estudio florístico y sinecológico de la vegetación en el cráter “Hoya de Rincón de Parangueo”, Valle de Santiago, Gto. Tesis de maestría. Colegio de Postgraduados. México. 99 pp.

Calderón de Rzedowski, G. y Rzedowski, J. (2004). Manual de malezas de la región de Salvatierra, Guanajuato. Flora del Bajío y de Regiones Adyacentes XX, 1-320.

Colwell, R. K. (2013). *EstimateS*: Statistical estimation of species richness and shared species from samples. Version 9. Persistent URL <purl.oclc.org/estimates>.

Cretcher, R., Rohan, D. y Rzedowski, J. (2010). Flores silvestres de San Miguel de Allende. Jardín Botánico Charco del Ingenio y R & D Publishing. 175 pp.

Cruz-José, J. L., García-González, M. R., Acevedo-Torres, J. B., Ángeles-Gómez, J. C., Fuentes-Hernández, V. y Martínez-González, J. E. (2012). Aspectos de la hidrología en el estado. En: La Biodiversidad en Guanajuato: Estudio de Estado Vol. I. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO)/Instituto de Ecología del Estado de Guanajuato (IEE). México. pp. 46-62.

Cuevas-Guzmán, R. y Núñez López, N. M. (2015). *Solanum edmundoi* (Solanaceae), una especie nueva de bejuco con aguijones del occidente de México. Revista Mexicana de Biodiversidad 86, 293-297.

Guadián-Marín, J. I. (2012). Flora y vegetación de la Sierra de Pénjamo, Guanajuato (México). Tesis de licenciatura. Universidad Michoacana de San Nicolás de Hidalgo, Facultad de Biología. Morelia, Michoacán, México. 157 pp.

Gutiérrez, J. y Solano, E. (2014). Afinidades florísticas y fitogeográficas de la vegetación del municipio de San José Iturbide, Guanajuato, México. Acta Botánica Mexicana 107, 27-65.

ISSN 2444-4936

Hernández-Hernández, V., González-García, S. M. y Colli-Mull, J.G. (2016). Licopodios y helechos de la Sierra de Pénjamo, Guanajuato. Revista de Ciencias Ambientales y Recursos Naturales 2, 44-50.

Hernández-Hernández V., Vargas-Gallaga C. E., Colli Mull J. G. y Jasso-Barrón M. (2017). Listado de licopodios y helechos del Cerro del Veinte, Irapuato, Guanajuato, México. Revista de Ciencias Ambientales y Recursos Ambientales 7, 39-48.

Hernández-Ramírez, A. M. y García-Méndez, S. (2015). Diversidad, estructura y regeneración de la selva tropical estacionalmente seca de la Península de Yucatán, México. Revista de Biología Tropical 63, 603-616.

INEGI (Instituto Nacional de Estadística y Geografía). (2015). SIATL (Simulador de Flujos de Agua de Cuencas Hidrológicas). Consultado en: http://antares.inegi.org.mx/analisis/red_hidro/SIATL/#. Fecha de consulta: 27 de Octubre del 2015.

Jiménez-Valverde, A. y Hortal, J. (2003). Las curvas de acumulación de especies y la necesidad de evaluar la calidad de los inventarios biológicos. Revista Ibérica de Aracnología 8, 151-161.

López, J. L. N. y Martínez, M. D. de S. (2009). Estudio florístico y de la vegetación del Cerro de Arandas en Irapuato, Guanajuato, Memorias del Programa Verano de la Ciencia 2009 y 11° Verano de la Ciencia de la Región Centro. Universidad Autónoma de Querétaro.

Mickel, J.T. y Smith, A. (2004). The Pteridophytes of Mexico. Memoirs of the New York Botanical Garden 88, 1-1054.

Moreno, C. E. (2001). Métodos para medir la biodiversidad. M & T-Manuales y Tesis SEA. 1, 1-83.

Mostacedo, B. y Fredericksen, T. S. (2000). Manual de métodos básicos de muestreo y análisis en Ecología Vegetal. El País. Bolivia. 87 pp.

Quijano-Carranza, J. A. y Rocha-Rodríguez, R. (2012). Los suelos de Guanajuato. En: La Biodiversidad en Guanajuato: Estudio de Estado Vol. I. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO)/Instituto de Ecología del Estado de Guanajuato (IEE). México. pp. 74-81.

Rzedowski, J. y Calderón de Rzedowski, G. (1987). El bosque tropical caducifolio de la región mexicana del Bajío. Trace 12, 12-21.

Rzedowski J. y Guevara-Féfer F. (1992). Burseraceae. Flora del Bajío y de Regiones Adyacentes 3, 1-46.

Rzedowski, J. y Calderón de Rzedowski, G. (2013). Datos para la apreciación de la flora fanerogámica del bosque tropical caducifolio de México. Acta Botánica Mexicana 102, 1-23.

Sahagún-Godínez, E., M. A. Macías R.., P. Carrillo R., N. Larrañaga G. y J.A. Vázquez G. (2014). Guía de campo de los arboles tropicales de la Barranca del río Santiago en Jalisco, México. Universidad Autónoma de Guadalajara. 313 pp.

SEMARNAT (Secretaría de Medio Ambiente y Recursos Naturales). (2010). Norma Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo. Diario Oficial de la Federación. 30 de diciembre de 2010, Segunda Sección. México. 77 pp.

Trejo-Vázquez, I. (1999). El clima de la selva baja caducifolia en México. Investigaciones Geográficas Boletín 39. Instituto de Geografía, UNAM. México, D.F. 40-52 pp.

Villaseñor, J. L. (2016). Checklist of the native vascular plants of Mexico. Revista Mexicana de biodiversidad 87, 559-902.

Zamudio, S. y Galván-Villanueva, R. (2011). La diversidad vegetal del estado de Guanajuato, México. Flora del Bajío y de Regiones Adyacentes. XXVII, 101 pp.

Zamudio, R. S. (2012). Diversidad de ecosistemas del estado de Guanajuato. En: La Biodiversidad de Guanajuato, Estudio de estado Vol. II. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad/Instituto de Ecología del Estado de Guanajuato. pp. 21-55.

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Anexo 1 List of families, genera and species present in the ravines El Paiste (PTE) y La Escondida (ESC) del Cerro del Veinte. H = Herbácea, B= Bejuco, Arb = Arbusto, A = Árbol.

Family / Species	Ravine		Habit
	Pte	Esc	
Licopodios			
Selaginellaceae			
Selaginella Delicatissima	X		H
Selaginella Lepidophylla	X	X	H
Selaginella Rupincola	X	X	H
Helechos			
Aspleniaceae			
Asplenium Exiguum	X		H
Asplenium Gentryi	X	X	H
Cystopteridaceae			H
Cystopterys Fragilis	X		H
Polypodiaceae			
Pleopeltis Polypodioides	X		H
Pleopeltis Thyssanolepis	X	X	H
Pteridaceae			
Adiantum Concinnum	X	X	H
Argyrochosma Incana	X		H
Argyrochosma Pallens		X	H
Astrolepis Sinuata	X	X	H
Bommeria Pedata		X	H
Cheilanthes Lozanii Var. Seemannii		X	H
Gaga Kaulfussii	X		H
Myriopteris Allosuroides		X	H
Myriopteris Aurea	X	X	H
Myriopteris Cucullans	X	X	H
Myriopteris Myriophylla	X	X	H
Pellaea Cordifolia	X	X	H
Pellaea Ovata	X		H
Pellaea Villosa	X		H
Woodsiaceae			
Woodsia Mexicana	X		H
Woodsia Mollis	X		H
Dicotyledoneae			
Acanthaceae			
Anisacanthus Pumilus	X		Arb
Dyschoriste Hirsutissima	X	X	H
Henrya Insularis	X	X	H
Justicia Candicans		X	Arb
Ruellia Lactea	X	X	H
Tetramerium Nervosum	X	X	H
Amaranthaceae			
Amaranthus Hybridus	X		H
Gomphrena Serrata	X	X	H
Iresine Grandis	X	X	Arb
Apiaceae			
Prionosciadium Watsonii	X		H
Apocynaceae			
Asclepias Linaria	X		H
Funastrum Pannosum		X	B
Mandevilla Foliosa		X	Arb
Matelea Chrysantha	X		B
Asteraceae			
Acourtia Reticulata	X		H
Ageratum Corymbosum	X		H
Barkleyanthus Salicifolius			
Bidens Bigelovii	X		H
Bidens Odorata		X	H
Bidens Triplinervia	X		H
Erigeron Bonariensis	X		H
Dahlia Coccinea	X		H
Galeana Pratensis	X		H
Lactuca Serriola	X		H
Montanoa Bipinnatifida	X	X	Arb
Psacalium Platylepis	X		H
Roldana Heracleifolius		X	Arb
Barkleyanthus Salicifolius	X		Arb
Sonchus Oleraceus	X		H
Tagetes Lucida	X		H
Tagetes Lunulata	X	X	H
Tagetes Micrantha	X		H
Trigonospermum Annuum		X	H
Vernonia Alamanii	X	X	Arb
Zinnia Peruviana	X	X	H
Begoniaceae			
Begonia Gracilis	X	X	H
Bignoniaceae			
Tecoma Stans		X	Arb
Brassicaceae			
Lepidium Virginicum	X		H
Burseraceae			
Bursera Bipinnata		X	Ar
Bursera Fagaroides		X	Ar
Bursera Palmeri	X		Ar
Bursera Penicillata		X	Ar
Cactaceae			
Coryphantha Elephantidens	X		H
Mammillaria Magnimamma	X	X	H
Myrtillocactus Geometrizans	X	X	H
Peniocereus Serpentinus	X		H
Stenocereus Pruinosus	X	X	H
Cannabaceae			
Celtis Caudata	X	X	Ar
Caricaceae			
Jarilla Caudata		X	H
Convolvulaceae			
Evolvulus Alsinoides		X	H
Ipomoea Hederifolia	X		B
Ipomoea Murucoides	X	X	Ar
Ipomoea Purpurea	X	X	T
Crassulaceae			
Echeveria Subrigida		X	H
Sedum Ebracteatum		X	H
Sedum Jaliscanum	X		H
Cucurbitaceae			
Cyclanthera Ribiflora	X		B
Schizocarpum Parviflorum	X	X	T
Euphorbiacea			
Cnidoscolus Angustidens		X	H
Croton Ciliatoglandulifer	X	X	Arb
Croton Morifolius	X	X	Arb
Euphorbia Tanquahuete	X	X	Ar
Jatropha Dioica		X	Arb
Manihot Caudata	X	X	Ar
Fabaceae			
Brongniartia Intermedia	X	X	Arb
Cologania Broussonetii	X	X	T
Dalea Foliolosa		X	H
Erythrina Coralloides	X	X	Ar
Eysenhardtia Polystachya		X	Ar
Hesperalbizia Occidentalis	X	X	Ar
Lysiloma Microphylla	X	X	Ar
Macroptilium Atropurpureum		X	T
Macroptilium Gibbosifolium	X		T
Nissolia Microptera	X	X	T
Phaseolus Vulgaris	X	X	T
Senna Hirsuta Var. Glaberrima	X		Arb
Senna Polyantha	X	X	Ar
Vachellia Farnesiana	X	X	Arb
Vachellia Schaffneri	X		Arb
Zapoteca Formosa	X	X	Arb
Juglandaceae			
Juglans Mollis	X	X	Ar
Loasaceae			
Mentzelia Aspera		X	H
Mentzelia Hispida	X		H
Loranthaceae			
Psittacanthus Palmeri		X	H
Lythraceae			
Cuphea Wrightii Var. Wrightii		X	H
Heimia Salicifolia	X	X	Arb
Malpighiaceae			
Aspicarpa Cynanchoides		X	B
Heteropterys Brachiata	X	X	B
Malvaceae			
Anoda Maculata		X	H
Ceiba Aesculifolia	X	X	Ar
Heliocarpus Terebinthinaceus	X	X	Ar
Pavonia Candida	X	X	Arb
Meliaceae			
Cedrela Odorata	X		Ar
Nyctaginaceae			
Mirabilis Jalapa	X		H
Mirabilis Longiflora		X	H
Pisoniella Arborescens	X		H
Oleaceae			
Fraxinus Uhdei	X		Ar
Onagraceae			
Lopezia Racemosa	X	X	H
Ludwigia Octovalvis	X		H
Opiliaceae			
Agonandra Racemosa	X	X	Ar

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Orobanchaceae			
Aphyllon Dugesii	X	X	H
Castilleja Tenuiflora	X		H
Oxalidaceae			
Oxalis Alpina	X	X	H
Piperaceae			
Peperomia Bracteata	X	X	H
Plumbaginaceae			
Plumbago Pulchella	X	X	H
Plumbago Zeylanica	X	X	H
Polemoniaceae			
Bonplandia Geminiflora	X	X	H
Loeselia Glandulosa	X		H
Loeselia Mexicana	X	X	Arb
Loeselia Pumila	X	X	H
Polygonaceae			
Persicaria Segetum	X		H
Ranunculaceae			
Clematis Grossa	X		B
Rhamnaceae			
Colubrina Triflora		X	Ar
Rubiaceae			
Bouvardia Laevis		X	Arb
Bouvardia Multiflora	X	X	Arb
Randia Canescens	X	X	Arb
Sapindaceae			
Cardiospermum Halicacabum		X	B
Serjania Triquetra	X	X	B
Saxifragaceae			
Heuchera Mexicana	X		H
Scrophulariaceae			
Buddleja Sessiliflora	X	X	Arb
Solanaceae			
Jaltomata Procumbens	X	X	H
Physalis Philadelphica	X	X	H
Solanum Diversifolium Subsp. Diversifolium	X	X	Arb
Solanum Edmundoi	X		B
Solanum Nigrescens	X		B
Talinaceae			
Talinum Paniculatum	X	X	H
Verbenaceae			
Lantana Camara	X		Arb
Lantana Hirta	X	X	Arb
Lippia Queretarensis	X	X	H
Verbena Carolina	X		H
Violaceae			
Pombalia Attenuata	X		H
Monocotyledoneae			
Asparagaceae			
Echeandia Flavescens	X		H
Milla Biflora	X		H
Alstroemeriaceae			
Bomarea Edulis	X		B
Bromeliaceae			
Tillandsia Achyrostachys	X		H
Tillandsia Dugesii	X		H
Tillandsia Grossispicata		X	H
Tillandsia Recurvata	X	X	H
Viridantha Atroviridipetala		X	H
Commelinaceae			
Commelina Erecta		X	H
Thyrsanthemum Floribundum	X	X	H
Tradescantia Crassifolia	X	X	H
Tripogandra Amplexicaulis		X	H
Tripogandra Purpurascens	X		H
Dioscoreaceae			
Dioscorea Galeottiana	X	X	B
Iridaceae			
Tigridia Vanhouttei	X	X	H
Orchidaceae			
Dichromanthus Cinnabarinus		X	H
Govenia Lagenophora	X		H
Sacoila Lanceolata	X		H
Poaceae			
Lasiacis Nigra	X		H
Melinis Repens	X	X	H
Pontederiaceae			
Heteranthera Peduncularis	X		H

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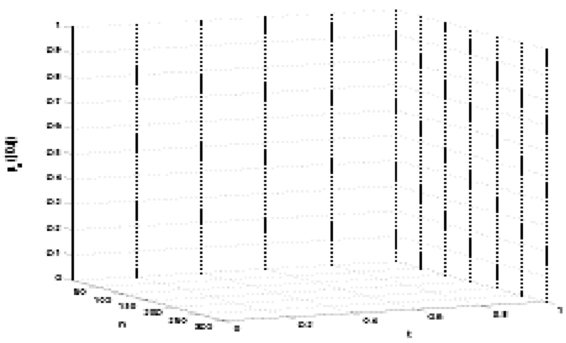

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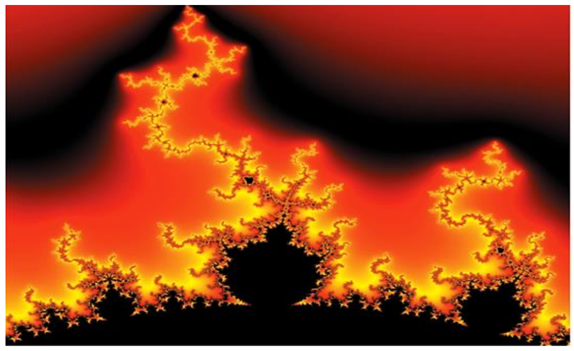

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