OENO One
VINE AND WINE OPEN ACCESS JOURNAL
Volume 52 > Number 4 > 2018

Contribution of Mexican scholars to viticultural and oenological research: where do we stand?

Guillermo Castillo*, Liliana Castro-López and Saúl Méndez

Escuela de Enología y Gastronomía, Universidad Autónoma de Baja California,
Carretera Transpeninsular Ensenada-Tijuana 3917, Colonia Playitas C.P. 22860 Ensenada, Baja California, México

Abstract

Wine consumption in Mexico has increased continuously over the last decade. However, domestic wine production is not sufficient to satisfy domestic demand, and foreign wine producers have been the main beneficiaries of the growth of the Mexican market. This highlights the need of Mexican winemakers for scientific evidence and technological innovations that can help to make better management choices both in the field and in the winery. This paper presents the results of a bibliometric study that aimed to investigate the contribution of the Mexican academic community to scientific literature in viticulture and oenology (1987-2017). Results indicate that Mexican academia has failed to keep pace with the constant growth of the wine industry in Mexico. The growth of scholarly scientific output in Mexico has been slower than that of other Latin American countries. In addition, Mexican scientific output relied to a large extent (36 %) on collaborations with research groups from developed countries, while collaborative papers with Latin American countries were comparatively rare (7.9 %). Domestic collaboration among Mexican institutions is still limited, as indicated by the low number of such publications (23.2 %) and by the considerable number of institutions producing papers independently (49 %). Agrosciences, biological sciences, chemistry, microbiology and health sciences were the main areas of research of Mexican academics.

Keywords: bibliometric analysis, Mexico, viticulture, oenology, research

Received: June 30, 2018; Accepted: August 7, 2018; Published: December 7, 2018
doi: 10.20870/oeno-one.2018.52.4.2275

*Corresponding author: castillo.guillermo@uabc.edu.mx

OENO One, 2018, **52**, 4, 273-278

Introduction

The increase of international competition is one of the most significant changes that the wine industry and wine market have undergone in the last 30 years. This growth has been triggered to a large extent by the process of "wine globalization", in which new wine-producing and -exporting countries have entered the wine business (Medina-Albaladejo *et al.*, 2014). During the last decade, wine consumption in traditional producing and consuming countries (e.g., Spain or France) has declined, whereas the production and consumption of wine has increased in countries such as Argentina, Chile, Australia, and Mexico. This shift in the market has triggered competition at an international level. An example of the discrepancy between production and consumption occurred in 2001, when Spain, France, and Italy together were responsible for more than half of the world's annual wine production, while their own per capita consumption dropped by around 40-50 %, generating a surplus in "Old World" wine production (Anderson and Nelgen, 2015; Bisson *et al.*, 2002). According to OIV (International Organisation of Vine and Wine) data, the level of competition in the wine sector will be further intensified in the coming years as a result of the effects of climate change on grape production (Jones, 2015; van Leeuwen and Darriet, 2016) and the consumer demand for socially and environmentally responsible viticulture and winemaking methods (Mariani and Vastola, 2015).

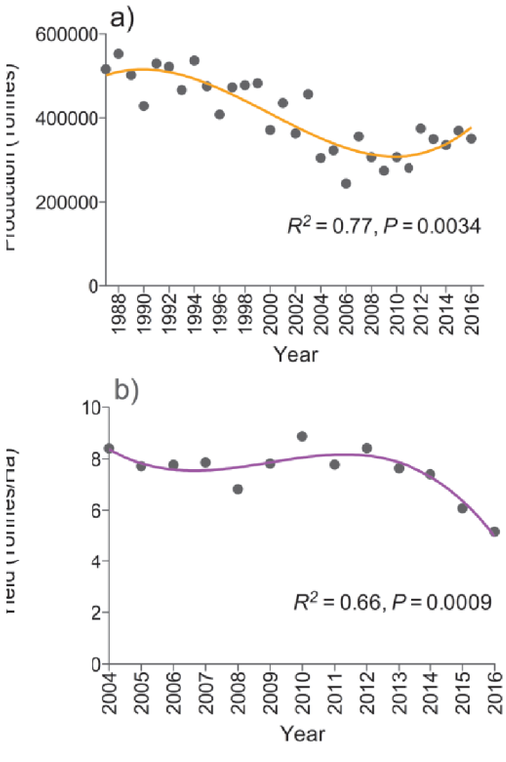

Figure 1. Chronological evolution of a) grape production for the period 1987-2016 (FaoStat, 2013) and b) wine grape yield for the period 2004-2016 (OEIDRUS-BC, 2018) in Mexico. Lines represent third order trend-lines.

Mexico has also been part of the process of wine globalization. This is reflected in an annual growth of 8 % in domestic consumption during the period 2000-2010 and of 12 % during the period 2010-2015 (Euromonitor International, 2016; López and Sotelo, 2014). Ironically, domestic grape production in Mexico today is around half what it was in 1987 (Figure &a) and wine grape yield has dropped in the years 2015 and 2016 (Figure 1b), probably as a result of the severe drought experienced from 2012-2015 in the main winegrowing areas (Robeson, 2015). As a consequence, foreign production (e.g., Chile, Argentina, Spain, and France) "has been the greatest beneficiary of the growth of the Mexican market" (López and Sotelo, 2014). This situation constitutes a complex scenario for Mexican wine producers, who will face challenges in the coming years due to water scarcity and other effects of climate change in the main wine grape producing areas (Acosta-Zamorano *et al.*, 2013; Muñoz and Sánchez, 2016). The expectation of imminent challenges intensifies the need of the wine sector worldwide for research, scientifically based evidence, and technological innovations that will enable better management choices in both vineyards and wineries (Aleixandre *et al.*, 2016).

A way to explore the intensity of research activity using qualitative and quantitative methods is to analyze the number and the authorship of scientific papers published in peer-reviewed journals. Recently, Aleixandre *et al.* (2013) found significant growth in the number of research papers concerning viticulture and oenology published by Latin American researchers, particularly those from Brazil, Argentina, and Chile. However, the development and characteristics of the contribution of Mexican academics to these areas remain under-studied. Thus, it is useful to develop an updated diagnostic of the contribution of Mexican scholars to scientific literature related to viticulture and oenology, and to study the evolution of this literature compared to that of other Latin American countries. To accomplish this, we conducted a bibliometric analysis of research and review articles published in peer-reviewed journals during the last 30 years, focusing on publications by authors affiliated with universities and research centers based in Mexico.

Method

1. Bibliometric database

We conducted an extensive survey of the peer-reviewed scientific literature through Internet searches in Elsevier's Scopus database. In a fashion similar to that employed by Cassi *et al.*(2012), searches included the following terms: "grapevine", "grapevines", "wines", "wine grape", "wine grapes", "wine production", "red wine", "red wines", "white wine", "white wines", "winemaking", "enology", "enologists", "viticulture", "oenology", "wine yeast", "wine yeasts", "winery", and "wineries". These searches led to a large number of papers that were analyzed for inclusion and filtered according to the authors' countries of affiliation so that at least one author was from the following countries: Argentina, Brazil, Colombia, Chile, Cuba, Ecuador, Mexico, Peru, Uruguay, or Venezuela. We only included articles classified as original research articles and reviews for the period 1987-2017 a suitable period to evaluate the growth of viticulture and oenology research in Latin America (Cassi *et al.*, 2012). From the resulting database we extracted the annual and total production of articles by country.

2. Collaboration network analysis

We then restricted our database to articles written by at least one author affiliated with an institution based in Mexico and extracted the name of the Mexican affiliation entity, the affiliation country of the co-authors, the affiliation country of the corresponding author, and the thematic area for each publication. We performed a network analysis to explore the collaboration network between Mexican and foreign scholars and the collaboration network among Mexican institutions. Finally, we extracted the main thematic area for each of the published papers.

Results

Our initial, worldwide search found 49,388 publications. After restricting the search to papers published by authors affiliated with Latin American institutions, we obtained 3,232 publications (3,106 research articles and 126 reviews). For the 1987-2017 period, Brazil was the country with the most published articles (1,529), followed by Chile (710), Argentina (557), Mexico (164), Uruguay (120), Colombia (50), Venezuela (36), Peru (27), Cuba (26), and Ecuador (13). Figure 2 shows the growth in the number of articles published per year in the five countries with the highest productivity in Latin America during the last 30 years. Brazil showed the highest annual publication growth, followed by Chile, Argentina, Mexico, and Uruguay.

When we restricted the database to papers written by authors with Mexican affiliations, we found 51 institutions that together produced 164 papers (152 research articles and 12 reviews). Results showed that 105 of these papers (63.53 % of total paper productivity) were written by a corresponding author affiliated with a Mexican institution. In addition, 86 papers (52.4 %) were the result of an international collaboration. Network analysis revealed that Mexican academics collaborated with co-authors from 27 countries. Co-authors from Spain, the United States, France, and Italy accounted for 67.9 % of total paper productivity, whereas co-authorships with researchers from other countries in Latin America represented only 7.9 %. Argentina and Brazil were the Latin American countries that collaborated the most with Mexican academics (Figure 3a).

Results also indicated that 38 papers (23.2 %) were the result of a national collaboration (i. e., involving at least two Mexican institutions). Interestingly, 50.2 % of the scientific productivity of the Mexican academia was generated by only 10 institutions. Universidad de Nacional Autónoma de México (UNAM) was shown to be the most productive institution with 15 publications, accounting for 9.41 % of the country's productivity, followed by Tecnológico Nacional de México (TNM) and Universidad Autónoma de Baja California (UABC), which contributed 14 (8.51 %) and 13 (7.91 %) papers, respectively. Network analysis also showed that 33 (51 %) academic institutions published papers in collaboration with other Mexican institutions.

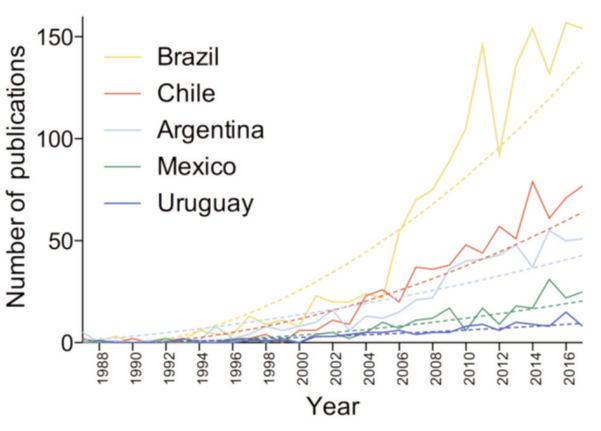

Figure 2. Annual growth of scientific productivity (number of publications) in Brazil, Chile, Argentina, Mexico and Uruguay for the 1987-2017 period. Dashed lines represent second order trend-lines.

OENO One, 2018, **52**, 4, 273-278

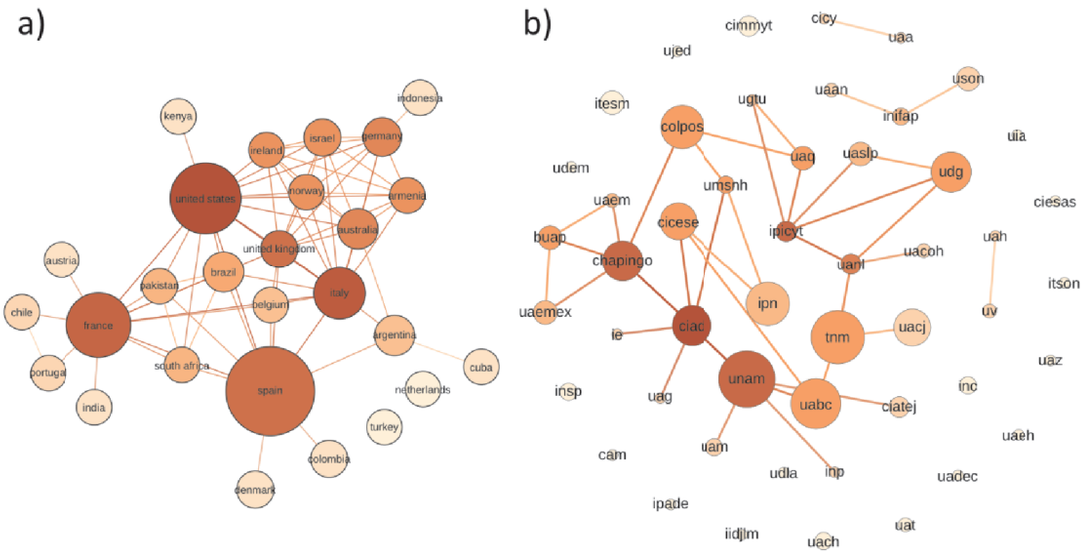

Figure 3. a) International and b) domestic collaboration network of Mexican academia in viticultural and oenological research. Node size correlates positively with the number of papers, while node color intensity correlates positively with the number of collaborations. Line color intensity correlates positively with the number of collaborations between a pair of nodes.

Universidad Nacional Autónoma de México (UNAM), Centro de Investigación en Alimentación y Desarrollo (CIAD), Universidad Autónoma de Chapingo (CHAPINGO), and Instituto Potosino de Investigación Científica y Tecnológica A.C. (IPICYT) were found to be the most collaborative institutions (Figure 3b). Finally, we found that all of the publications authored by Mexican academics were grouped into 12 thematic areas, with agricultural sciences (18.9 %), chemistry (15.9 %), biological sciences (11.6 %), microbiology (11 %) and health sciences being the most studied topics (Figure 4).

Discussion

Since scientific papers are the primary means of communicating and preserving scientific advances, the study of scholarly scientific production is a good proxy for knowledge generation and research progress (Basualdo *et al.*, 2016). We conducted a bibliometric study to describe the contribution of the Mexican academic community to scientific literature regarding viticulture and oenology, and to compare its evolution with that of other Latin American countries.

Our results indicate a significant growth in the number of scholarly publications related to scientific aspects of winemaking throughout Latin America over the last 30 years. This is in line with previous studies by Aleixandre *et al.* (2013), who found a growing interest in viticultural and oenological research for the period 2006-2010. However, the growth in paper production by Mexican scholars has been relatively slow compared to that of Brazil, Chile, and Argentina, even though in this region Mexico is only second to Brazil in terms of researchers (CEPAL, 2016). If we consider the constant growth of domestic wine consumption in the last 10 years (8-12 % per year), and the current need to increase grape production (López and Sotelo, 2014), it is fair to say that the Mexican academia is failing to keep pace with the continuous growth of the wine sector.

Most of the published papers were written by a corresponding author belonging to a Mexican institution. However, it is worth noting that a considerable part of the total production was developed under the leadership of foreign institutions. Foreign participation in scholarly scientific productivity in Latin America is 30.6 % (Aleixandre *et al.*, 2013); we found that 59 papers, or 35.97 % of the total production, were the product of an international collaboration. This is also reflected in the network analysis, which showed a high level of collaboration with developed countries (Spain, the United States, France, or Italy) but few collaborations with other Latin American countries. We assert that in order for the Mexican academic community to benefit from the scientific knowledge of others, institutional efforts must aim to encourage international collaborations, especially with other countries in Latin America.

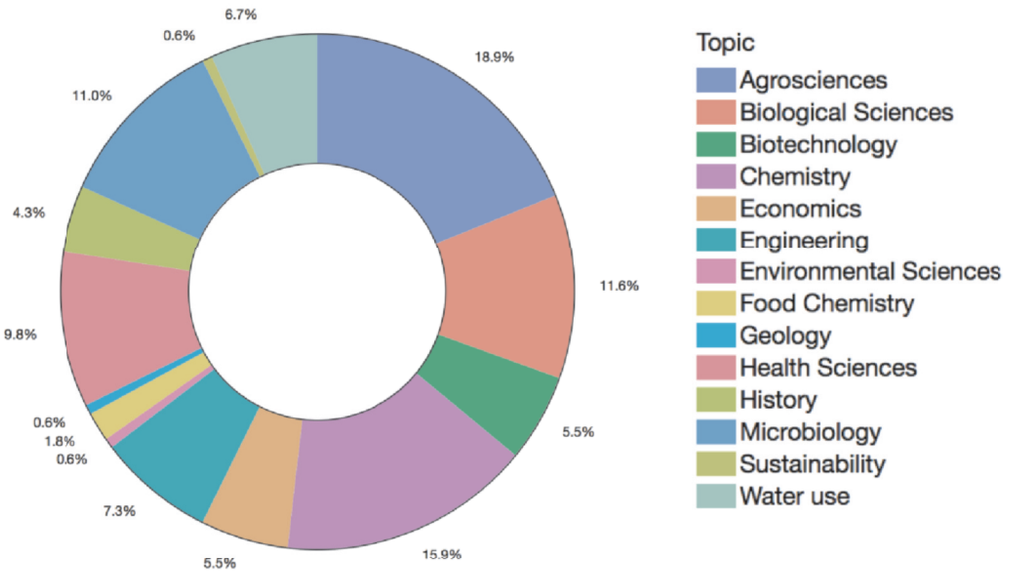

Figure 4. Thematic areas in Mexican scholarly publications concerning viticulture and oenology from 1987 to 2017.

Research activity concerning oenology and viticulture in Mexico occurs in an isolated manner and is conducted by relatively few institutions. This is indicated by the low number of publications generated through national collaborations (38, or 23.2 %) and by the considerable number of institutions (49 %) that have produced papers independently. These results highlight the need to encourage domestic collaborative research; doing so will have a positive effect on both the quantity and quality of scientific production (Ding, 2011). Collaborative productivity has become essential in multidisciplinary fields like viticulture and oenology, where successful research depends on the joint efforts of scientists with diverse skill sets ranging from theoretical knowledge to solid experience in the field and the laboratory (Bu *et al.*, 2018). Half of the domestic scholarly scientific production is conducted by 10 institutions that work as collaborative hubs (Figure3a). We call upon these institutions to facilitate collaborative research projects through the creation of an inter-institutional specialized research center such as the *Institut des Sciences de la Vigne et du Vin* in Bordeaux (France), or the *Instituto de Ciencias de la Vid y del Vino* in Logroño (Spain).

Finally, we found that scholarly scientific production was grouped into 12 distinct research topics. This reflects the multidisciplinary nature of the field, as noted by Glänzel and Veugelers (2006). However, the results indicated that more than half (57 %) of the publications were concentrated in only five thematic areas (agrosciences, biological sciences, chemistry, microbiology, and health sciences). This presents a challenge to Mexican academics, who will soon have to tackle pressing research topics in viticulture and oenology, such as sustainable wine production under climate change (Aurand, 2015), while continuing to conduct basic research.

Conclusion

Increased competition within the wine market is a trend that will continue at a global scale. Mexico, like other countries in Latin America, has been experiencing an increased demand for wine. However, wine production in Mexico is currently insufficient to satisfy national needs. This highlights the necessity for greater innovation and competitiveness among domestic wine makers. Scientific research plays a fundamental role in meeting these goals. We have found that Mexican scholars are failing to keep pace with the continuous growth of the Mexican wine sector. Inter-institutional academic efforts must be made to achieve a higher degree of scientific autonomy while increasing international collaboration dynamics, particularly with other countries in Latin America. Because of Mexico's current research capacities in viticulture and oenology, the creation of a specialized national research center dedicated to these areas seems feasible. Creating such a center will strengthen the research on priority topics such as sustainable production, adaptation to climate change, and water use efficiency. Public policy should also promote collaborative workspaces that bring together scientists, viticulturists, oenologists, and stakeholders in the design and implementation of national

OENO One, 2018, **52**, 4, 273-278

strategies aimed at achieving the sustainability of the Mexican wine sector.

Acknowledgements: GC and LCL acknowledge support from Programa para el Desarrollo Profesional Docente, para el Tipo Superior (PRODEP).

References

Acosta-Zamorano D., V. Macías-Carranza, L. Mendoza-Espinosa and A. Cabello-Pasini, 2013. Effect of treated wastewater on growth, photosynthesis and yield of Tempranillo grapevines (*Vitis vinifera*) in Baja California, Mexico. Agrociencia-Mexico **47**, 753-766. http://ref.scielo.org/7rg9sj

Aleixandre J.L., E. Bordeu, J.-L. Aleixandre-Tudó, M. Bolaños and R. Aleixandre-Benavent, 2013. Scientific productivity and collaboration in viticulture and enology in Latin American countries. Ciencia e Investigación Agraria **40**, 429-443. doi:/10.4067/ S0718-16202013000200017

Aleixandre J.L., J.-L. Aleixandre-Tudó, M. Bolaños-Pizarro and R. Aleixandre-Benavent, 2016. Viticulture and oenology scientific research: the Old World versus the New World wine-producing countries. International Journal of Information Management **36**, 389-396. doi:/10.1016/j.ijinfomgt.2016.01.003

Anderson K. and S. Nelgen, 2015. *Global wine markets, 1961 to 2009: a statistical compendium*. University of Adelaide Press. doi:/10.1017/UPO9780987073013

Aurand J.-M, 2015. The major challenges of the vitivinicultural sector: role and strategy of the OIV. *In XV Congresso Latino-Americano de Viticultura e Enologia*. Bento gonçalves, Brasil.

Basualdo J.A., M.S. Grenóvero, E. Bertucci and N.B. Molina, 2016. Bibliometric analysis of scientific literature on intestinal parasites in Argentina during the period 1985–2014. Revista Argentina de Microbiología **48**, 171-179. doi:/10.1016/j.ram.2016.03.005

Bisson L.F., A.L. Waterhouse, S.E. Ebeler, M.A. Walker and J.T. Lapsley, 2002. The present and future of the international wine industry. Nature **418**, 696-699. doi:/10.1038/nature01018

Bu Y., Y. Ding, J. Xu, X. Liang, G. Gao and Y. Zhao, 2018. Understanding success through the diversity of collaborators and the milestone of career. Journal of the Association for Information Science and Technology **69**, 87-97. doi:/10.1002/asi.23911

Cassi L., A. Morrison and A.L. Ter Wal, 2012. The evolution of trade and scientific collaboration networks in the global wine sector: a longitudinal study using network analysis. Economic Geography **88**, 311-334. doi:/10.1111/j.1944-8287.2012.01154.x

CEPAL (Comisión Económica para América Latina y el Caribe), 2016. Ciencia, tecnología e innovación en la economía digital. *In Segunda Reunión de la Conferencia de Ciencia, Innovación y Tecnologías de la Información y las Comunicaciones de la CEPAL*. https://repositorio.cepal.org/bitstream/handle/11362/40530/3/S1600833_es.pdf

Ding Y, 2011. Scientific collaboration and endorsement: network analysis of coauthorship and citation networks. Journal of Informetrics **5**, 187-203. doi:/10.1016/j.joi.2010.10.008

Euromonitor International, 2016. *Alcoholic drinks in Mexico*. http://www.euromonitor.com/alcoholic-drinks-in-mexico/report

FaoStat F, 2013. *Statistical database (agriculture data, agricultural production)*. Food and Agriculture Organization of the United Nations. http://www.fao.org/faostat/

Glänzel W. and R. Veugelers, 2006. Science for wine: a bibliometric assessment of wine and grape research for wine-producing and consuming countries. American Journal of Enology and Viticulture **57**, 23-32. http://www.ajevonline.org/content/57/1/23

Jones G.V, 2015. Grapevines in a changing environment: a global perspective. *In Grapevine in a changing environment: a molecular and ecophysiological perspective*, eds Gerós H., Chaves M.M., Gil H.M. and Delrot S., pp. 1-17. Wiley-Blackwell. doi:/10.1002/9781118735985

López V. and C. Sotelo, 2014. Los vinos del Valle de Guadalupe: análisis de su comercialización. European Scientific Journal **10**, 90-106. https://eujournal.org/index.php/esj/article/viewFile/2684/2536

Mariani A. and A. Vastola, 2015. Sustainable winegrowing: current perspectives. International Journal of Wine Research **7**, 37-48. doi:/10.2147/IJWR.S68003

Medina-Albaladejo F.J., J.-M. Martínez-Carrión and J.-M. Ramón-Muñoz, 2014. El mercado mundial de vino y la competitividad de los países del Hemisferio Sur, 1961-2010. América Latina en la Historia Económica **21**, 40-83. doi:/10.18232/alhe.v21i2.568

Muñoz A.R.B. and M.D.V. Sánchez, 2016. Productividad en la Industria de la Uva y la eficiencia de los recursos disponibles en el Valle de Guadalupe, Baja California. Semestre Económico **5**, 1-19. http://www.revistaepgunapuno.org/index.php/SECONOMICO/article/view/4/1

OEIDRUS-BC, 2018. *Series Históricas Agrícolas*. Oficina Estatal de Información Para el Desarrollo Rural Sustentable of Baja California. http://www.oeidrus-bc.gob.mx/

Robeson S.M, 2015. Revisiting the recent California drought as an extreme value. Geophysical Research Letters **42**, 6771-6779. doi:/10.1002/2015GL064593

van Leeuwen C. and P. Darriet, 2016. The impact of climate change on viticulture and wine quality. Journal of Wine Economics **11**, 150-167. doi:/10.1017/jwe.2015.21