

ANALYSIS OF THE COLLABORATION BETWEEN THE US AND THE EU IN VITICULTURE AND OENOLOGY

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ABSTRACT

The network of scientific collaboration in viticulture and oenology between the United States and the European Union was studied for the period 1991-2010. A total of 498 articles were published collaboratively during this time. The most collaborative institutions in the US were the University of California Davis and Cornell University (New York), and the most collaborative institutions in the EU were Institut Nationale de la Recherche Agronomique (France), the Italian universities of Milan, Bologna and Udine, and the Spanish University of Barcelona. We note a considerable increase in collaboration in recent years, with the University of California Davis situated in a central position in the network.

- Keywords: bibliometric indicators, collaboration networks, European Union, scientific publications;
United States of America, viticulture and oenology research -

INTRODUCTION

The European Union is the largest producer of wine in the world. It is also the largest exporter and importer of wine in the world, highlighting the socio-economic importance of the wine sector in this area. Wine consumption in the United States has increased over the last ten years at a constant rate of approximately 3% per year, which is slightly lower than the consumption in France and Italy. In the coming years, the United States is expected to overtake these Countries to become the largest wine market in the world. Although the total consumption of wine is considerable, consumption per capita in the United States remains below Countries with older traditions of winemaking. This phenomenon may be considered an indicator of growth potential (FERNÁNDEZ *et al.*, 2006).

Wine imports have increased significantly in recent years from the European Union, which is the main supplier of wine to the United States. Three quarters of the wine consumed in the United States is of domestic origin, whereas imported wines have a quota of 25% (CBI, 2009). These commercial transactions make scientific and technical cooperation between the European Union and the United States increasingly more important. Extensive collaboration in research in this area has produced large numbers of collaborative journal articles on the wine trade.

This study provides a bibliometric analysis of collaborative research on wine and grapes published in the United States of America and the European Union during the 1991-2010 period. According to GLÄNZEL and VEUGELERS (2006), BEAVER and ROSEN (1979) and LUUKKONEN *et al.* (1992), international collaboration allows researchers to exchange scientific information with their international colleagues on the latest scientific developments, to gain access to the best equipment, facilities, and talent, and to participate in large-scale research projects that are beyond the financial capabilities of individual Countries.

METHODS AND DATA SOURCES

The articles under analysis were obtained from the Science Citation Index Expanded (SCIE) database, accessed via the Web of Knowledge platform from terminals at the Universidad Politécnica de Valencia (Spain). Only "citable documents" were considered (that is, papers published as articles, letters, notes or reviews), excluding documents such as book reviews, summaries of communications at conferences, reprints, news and bibliographic articles.

To define the field of "wine research", we used the same strategy employed by GLÄNZEL and VEUGELERS (2006) in a previous paper and combined three components: a) specific search

words, b) institutional addresses, and c) European Union Countries combined with the United States.

First, for the specific search words, we used the following strategy:

TS = (grapevin* or wines or "wine grap*" or "wine pro*" or "red wine*" or "white wine*" or winemaking or enolog* or viticult* or oenolog* or "wine cell*" or "wine yeast*" or winery or wineries).

The search was restricted to the field "topic", which retrieved records if the above-mentioned terms were included in the titles, keywords or abstracts of articles.

Second, for institutional addresses, we used the following strategy:

AD = (enolog* or viticult* or oenol*), where AD was the label of the authors' institutional address.

Finally, we limited the search to articles that were signed by at least one European Union Country and United States in the 'address' field of the search options of the SCIE database. The current European Union Countries are Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom (which includes England, Scotland, Wales, and Northern Ireland).

For some terms, the root was used (truncating the word with an asterisk) to obtain all of the documents associated with the derived words (e.g., by using the truncation enolog*, the SCIE database finds enology, enological, enologist, and so on).

The analysis was limited to 20 years (the period from 1991 to 2010). In order to identify the institutions and Countries with high and increasing citation rates, the citation/document rates by 5-year period were calculated.

The final records were exported to a relational database using the proprietary software Bibliometrics. Variants of the names of authors or institutions were unified because this information does not always appear standardised in SCIE. The following step was to analyse the information to obtain bibliometric indicators and to identify all combinations of pairs of authors and institutions in each paper to quantify the number of co-authorships (ie, the presence of joint signatures of authors or institutions in different articles). We examine publication productivity using a normal count or full counting scheme, where equal credit is given to all contributors; one full unit is assigned to each author, or each institution or Country involved in a scientific paper, in opposition to the fractional count (adjusted count), where each co-authored paper are divided by the number of co-authors. This information formed the basis for identifying research groups. The software Pa-

jek, designed for the analysis and visualisation of networks, was used for the construction and graphical representation of the research groups (BATAGELJ and MRVAR, 2001).

RESULTS

1. General data: annual productivity and journals

During the 1991-2010 period, 498 articles were published: 452 original articles (90.76%), 34 reviews (6.83%), 8 notes (1.6%), and 4 letters (0.8%). Most of them (43%) were published in the last five years, making 2009 the most productive year (n=51) (Fig. 1). In contrast, 73% of papers were published during the 2001-2010 decade, and the remaining 27% were published in the 1990s.

Papers were published in 237 different journals. The American Journal of Enology and Viticulture was the most productive journal, with 50 papers published, followed by the Journal of Agricultural and Food Chemistry, with 33. Both of these journals were edited in the United States. The VITIS German journal published 29 articles, and 3 other journals published more than 10 articles: Phytopathology (n=14), Plant Disease (n=14) and Applied and Environmental Microbiology (n=11). Table 1 shows the 33 journals with three or more published articles distributed by five-year periods and includes the 2009 impact factor and Country of publication.

The journals with the largest impact factors were the Proceedings of the National Academy of Sciences of the United States of America (FI=9,771), followed by BMC Genomics (FI=4,206), edited in United Kingdom, and Journal of Chromatography A (FI=4,194), edited in The Netherlands. As shown in the table, the most productive journals were published in the United States (8 journals), the United Kingdom (4 journals), Germany (3 journals), The Netherlands (2 journals) and Italy (one journal).

2. Publication output and citation impact by Country

For the comparative analysis of national publication activity and citation impact, Table 2 shows the Countries with more than one published paper and lists the number of papers published during the period, citations and the rate of citations per document. The United States, which had the highest share of publication output and citations (498 papers and 13,630 citations), was followed by Italy, France, Spain and Germany, with 146, 117, 73 and 50 papers, respectively. This ranking is similar for citations, with the exception that Austria and the United Kingdom had more citations than Germany. Among the most productive Countries, the highest rate of citations per papers belonged to Austria (102.3), followed by Spain (46.6). The UK is the Country with the highest increase in the rate of citations per document in the 2006-2010 period.

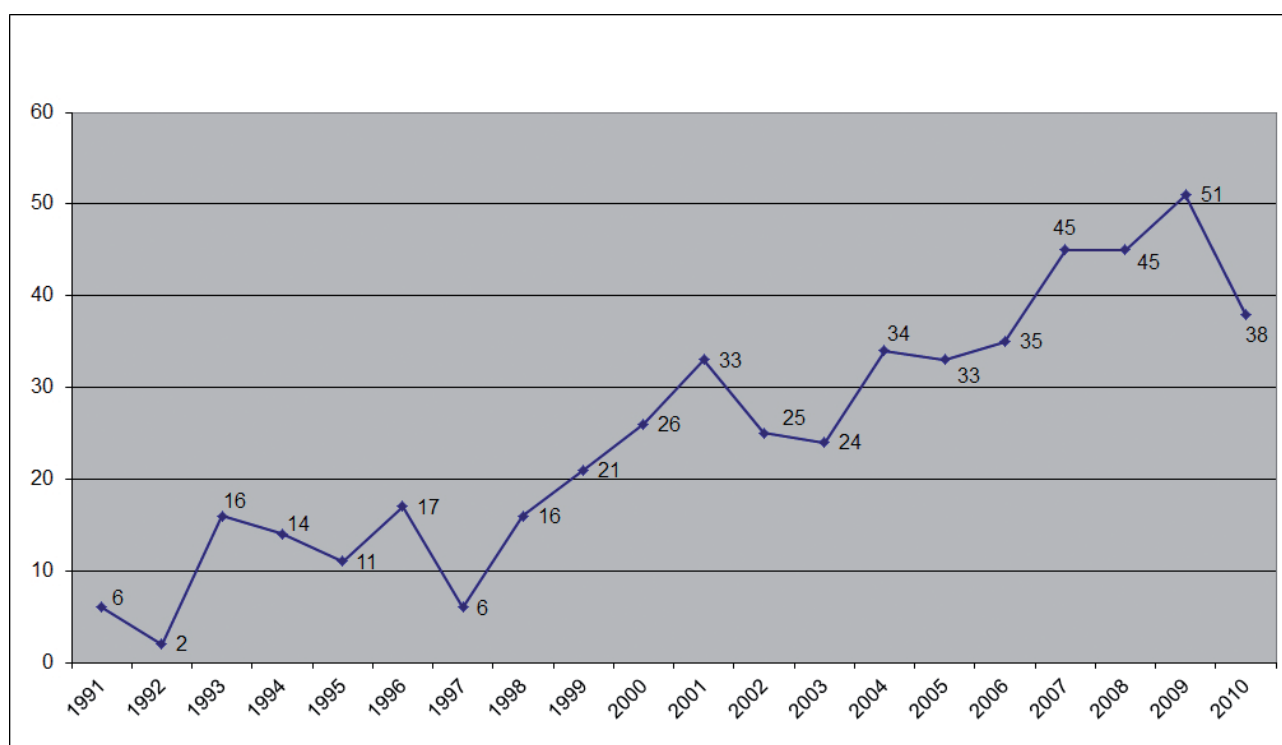


Fig. 1 - Evolution of publication output from 1991 to 2010.

Table 1 - Journals with 4 or more published papers.

Journal title	1991-1995	1996-2000	2001-2005	2006-2010	Total	IF 2010*	Journal Country
American Journal of Enology and Viticulture	13	9	13	15	50	1.667	United States
Journal of Agricultural and Food Chemistry	2	10	11	10	33	2.816	United States
Vitis	8	8	5	8	29	0.662	Germany
Plant Disease	3	5	2	4	14	2.387	United States
Phytopathology	6	2	2	4	14	2.428	United States
Applied and Environmental Microbiology	1	1	5	4	11	3.778	United States
Theoretical and Applied Genetics	-	2	3	4	7	3.264	Germany
Plant Pathology	-	2	4	4	6	2.237	United Kingdom
Proceedings of the National Academy of Sciences of the United States of America	-	1	-	4	5	9.771	United States
Food Chemistry	-	1	3	1	5	3.458	United Kingdom
Annals of Applied Biology	-	1	2	3	5	1.681	United States
Journal of Applied Microbiology	-	2	1	2	5	2.365	United Kingdom
Journal of Cardiovascular Pharmacology	-	1	2	2	5	2.406	United States
European Journal of Plant Pathology	-	2	1	2	5	1.575	Netherlands
Journal of Chromatography A	1	2	1	1	5	4.194	Netherlands
Journal of Phytopathology	1	1	-	2	4	0.937	Germany
BMC Genomics	-	-	-	4	4	4.206	United Kingdom
Plant Cell Reports	2	1	-	1	4	2.279	Germany
Journal OF Plant Pathology	-	-	1	3	4	1.054	Italy
14 journals with 3	-	-	-	-	42		
37 journals with 2	-	-	-	-	74		
168 journals with 1	-	-	-	-	168		
Total	49	86	149	214	498		

3. Institutional productivity and citations

The published papers reflected involvement by 691 institutions, with the University of California Davis contributing the most (149 publications). Other American institutions that collaborated with the European Union were Cornell University (New York) through the departments of Food Science and Technology, Plant Pathology and Horticulture Sciences and the Agricultural Research Service of the United States Department of Agriculture (n=27) (Table 3).

Among European Union institutions, the most collaborative institutions with the US were Institut Nationale de la Recherche Agronomique (France), the Italian universities of Milan, Bologna and Udine, and the Spanish University of Barcelona.

The literature search was limited to articles that were signed by European Union and US institutions. Therefore, institutions that did not belong to these Countries included foreign institutions who had published articles in conjunction with these Countries, such as the University of Stellenbosch (South Africa; n=6), the Australian Wine Research Institute (Australia; n=3), and the University of Basel (Switzerland; n=2), among others.

In terms of the citations received, the most frequently cited institution was also the University of California (n=5695), followed by the University of Barcelona (Spain; n=1931), the Institut Nationale de la Recherche Agronomique (France; n=342), the Australian Res Ctr GmbH (n=1135) and the Agricultural Research Service-United States Department of Agriculture (US, n=1029). Eighty institutions received 100 or more citations (11,6%), 454 (65,7%) received 10 or more citations and only 28 received no citations. It should be stressed the fact some institutions such as the Agricultural Research Service-United States Department of Agriculture (Usa), the Consejo Superior de Investigaciones Cientificas (Spain) and the University of Udine (Italy) have a remarkable growth in the rate of citations per document in the 2006-2010 period.

Table 2- Papers published and citations by Countries.

Country	Documents (D)					Cites (C)						Rate C/D			
	1991-1995	1996-2000	2001-2005	2006-2010	Total	1991-1995	Rate C/D	1996-2000	Rate C/D	2001-2005	Rate C/D		2006-2010	Rate C/D	Total
USA	49	86	149	214	498	1,822	37.18	5,264	61.21	3,960	26.58	2584	12.07	13,630	27.4
Italy	23	21	36	66	146	929	40.39	866	41.24	1,183	32.86	874	13.24	3,852	26.4
France	11	20	29	57	117	207	18.82	1217	60.85	1,256	43.31	628	11.02	3,308	28.3
Spain	11	10	21	31	73	635	57.73	1745	174.5	745	35.48	276	8.90	3,401	46.6
Germany	3	8	24	15	50	69	23	173	21.63	441	18.38	65	4.33	748	15
UK	-	10	9	28	47	-	-	213	21.3	186	20.67	956	34.14	1,355	28.8
Hungary	5	6	13	17	41	71	14.2	94	15.67	157	12.08	146	8.59	468	11.4
Denmark	-	6	7	5	18	-	-	574	95.67	92	13.14	52	10.4	718	39.9
Netherlands	-	1	6	9	16	-	-	315	315	199	33.17	116	12.89	630	39.4
Austria	-	4	6	5	15	-	-	1199	299.75	290	48.33	45	9	1,534	102.3
Australia	1	1	5	7	14	4	4	48	48	75	15	57	8.14	184	13.1
Portugal	-	6	5	2	13	-	-	121	20.17	157	31.4	12	6	290	22.3
Switzerland	2	4	4	7	13	49	24.5	-	-	186	46.5	113	16.14	348	26.8
Canada	-	4	1	6	11	-	-	162	40.5	13	13	79	13.17	254	23.1
Greece	1	-	2	7	10	1	1	-	-	11	5.5	88	12.57	100	10
Other 40 countries with less than 10 documents	9	12	30	71	122	185	-	742	9	435	6.75	1426	29.89	2,788	21.8
Total	115	195	347	547	1,204	3,972		12,733		9,386		7,517		33,608	

3. Authors' productivity and citations

The 498 articles were published by 2028 different authors, of whom 1629 (80,3%) published a single article. Table 4 presents authors with five or more published papers, the number of citations received and the evolution of these variables from 1991 to 2010. The most productive author was Dipak K Das (n=35), followed by Andrew L Waterhouse (n=25) and two authors with 20 articles respectively, Carole P Meredith and Marc Fuchs.

Regarding the citations (Table 2), five authors received more than one thousand citations. The most frequently cited authors were Rosa M Lamuela-Raventos (n=1847), followed by Andrew L Waterhouse (n=1751), Dipak K Das (n=1299), VL Singleton (n=1140) and R Orthofer (n=1123). Singleton and Orthofer are not included in Table 3 because they published only two and one articles, respectively; 95% of the authors were cited at least once, and the remaining 5% received no citations.

4. Indicators of collaboration and networks

The collaboration index (average number of authors per paper) was 6,2 for the entire period, increasing from 4.7 in the first five years to 7.4 in the latter five-year period (results not shown). Regarding collaboration between the US and European Countries, the Country with the most papers was Italy (n=146), followed by France (n=117), Spain (n=73) and Germany (n=50). Other Countries that published articles in collaboration with the US and at least one EU Country (that is, a triple collaboration) were Australia (n=14), Switzerland (n=13), Canada (n=11), South Africa (n=9), Israel (n=6) and the People's Republic of China (n=5), among others.

For the representation of networks of collaboration, a threshold of 5 co-authored articles was used. Eighteen groups were created with different components or numbers of authors in each group (Fig. 2). The largest group had 19 components and two nuclei: in the first one (with a stellar structure), the central author was Meredith, whereas in the second one (with a spherical structure due to the high degree of collaboration between members), the central authors were Velasco and Traggio. The authors that linked both nuclei were This and Grando. In the second group, with 13

Table 3 - Institutions with more than 5 papers.

Institution	Documents (D)					Cites (C)							Rate C/D		
	1991-1995	1996-2000	2001-2005	2006-2010	Total	1991-1995	Rate C/D	1996-2000	Rate C/D	2001-2005	Rate C/D	2006-2010		Rate C/D	Total
	Univ. Calif Davis (USA)	20	37	48	44	149	796	39.8	3,083	83.32	1104	23		712	16.18
Cornell Univ. (USA)	12	12	11	33	68	227	18.92	314	26.17	90	8.18	137	4.15	768	
Institut Nationale de la Recherche Agronomique (France)	7	8	12	23	50	115	16.43	433	54.13	462	36.5	263	11.43	1273	
Agricultural Research Service-United States Department of Agriculture(USA)	5	3	10	9	27	416	83.2	63	21	231	23.1	319	35.44	1029	
Univ. Connecticut (USA)	-	2	8	14	24	-	-	288	144	284	35.5	220	15.71	792	
Univ. Milan (Italy)	-	6	8	9	23	-	-	347	5783	255	31.88	144	16	746	
Univ. Bologna (Italy)	12	2	1	6	21	600	50	45	22.5	14	14	22	3.67	681	
Consiglio Nazionale delle Ricerche (Italy)	4	3	6	5	18	146	36.5	61	20.33	85	14.17	41	8.2	333	
Univ Udine (Italy)	5	1	5	7	18	108	21.6	36	36	243	48.6	156	22.29	543	
Univ Barcelona (Spain)	5	6	4	1	16	528	105.6	1,266	211	121	30.25	16	16	1,931	
Oregon State Univ. (USA)	-	3	5	8	16	-	-	68	22.67	84	16.8	92	11.5	244	
Univ. Calif Berkeley (USA)	2	5	1	8	16	131	65.5	185	37	13	13	52	6.5	381	
Harvard Univ. (USA)	-	5	1	9	15	-	-	711	142.2	11	11	101	11.22	823	
Univ. Florence (Italy)	2	5	4	3	14	131	65.5	260	52	29	7.25	37	12.33	457	
Univ. Bari (Italy)	4	2	4	4	14	122	30.5	40	20	79	19.75	12	3	253	
Consejo Superior de Investigacion. Cientificas (Spain)	-	3	5	5	13	-	-	412	137.33	268	53.6	116	23.2	796	
Univ. Bordeaux 2 (France)	1	1	4	7	13	25	25	63	63	160	40	55	7.86	303	
Univ. Strasbourg 1 (France)	-	-	1	11	12	-	-	-	-	4	4	41	3.73	45	
Washington State Univ. (USA)	1	3	2	4	10	25	25	64	21.33	22	11	38	9.5	149	
Univ. Reims (France)	-	1	5	4	10	-	-	76	76	280	56	32	8	388	
Univ. Hohenheim (Germany)	-	3	5	1	9	-	-	44	14.67	30	6	2	2	76	
Res. Inst. Viticulture & Enol. Kecskemet (Hungary)	1	1	1	5	8	13	13	8	8	4	4	20	4	45	
Szent Istvan Univ (Hungary)	-	-	4	4	8	-	-	-	-	11	2.75	16	4	27	
Virginia Polytech Inst. & State Univ. (USA)	-	1	4	2	7	-	-	67	67	268	67	27	13.5	362	
Univ. Georgia (USA)	-	3	2	2	7	-	-	169	56.33	64	32	25	12.5	258	
Natl. Univ. Ireland Univ. Coll Cork (Ireland)	-	2	3	2	7	-	-	26	13	13	4.33	2	1	41	
Univ. Padua (Italy)	-	1	3	3	7	-	-	36	36	207	69	174	58	417	
Hungarian Acad. Sci. (Hungary)	2	3	1	1	7	20	10	39	13	4	4	1	1	64	
Debrecen Univ. Med. (Hungary)	-	-	3	4	7	37	37	-	-	32	10.67	48	12	80	
Univ. Turin (Italy)	1	2	1	3	7	37	37	84	42	113	113	27	9	261	
Inst. Valenciano Invest. Agr. (Spain)	1	-	-	5	6	8	8	-	-	-	-	13	2.6	21	
IASMA Res. Ctr. (Istituto Agrario San Michele all'Adige. Italy)	-	-	-	6	6	-	-	-	-	-	-	246	41	246	
Univ. Florida (USA)	-	-	4	2	6	-	-	-	-	34	8.50	11	5.5	45	
Univ. Católica Portuguesa (Portugal)	-	4	2	-	6	-	-	37	9.25	11	5.50	-	-	48	
Missouri State Univ (USA)	-	-	2	6	6	-	-	-	-	-	-	18	3	18	
Univ. Basilicata (Italy)	1	2	2	1	6	16	16	46	23	67	33.50	9	9	138	
Univ. Calif Riverside (USA)	2	1	2	1	6	11	5.5	9	9	12	6	1	1	33	
Univ. Bourgogne (France)	-	2	1	3	6	-	-	140	70	8	8	7	-	155	
Centre National de la Recherche Scientifique (France)	-	1	1	4	6	-	-	24	24	5	5.00	38	9.5	67	
Univ. Naples Federico 2 (Italy)	-	-	1	6	6	-	-	-	-	-	-	60	10	60	
Univ. Stellenbosch (South Africa)	-	1	1	4	6	-	-	63	63	18	18.00	27	6.75	108	
Tech. Univ. Denmark (Denmark)	-	5	1	-	6	-	-	523	104.6	11	11.00	-	-	534	

Table 4 - Authors with more than 5 papers.

Author	Documents (D)					Cites (C)				
	1991-1995	1996-2000	2001-2005	2006-2010	Total	1991-1995	1996-2000	2001-2005	2006-2010	Total
Das, Dipak K.	-	4	12	19	35	-	576	391	332	1,299
Waterhouse, Andrew L.	6	9	6	4	25	596	936	187	32	1,751
Meredith, Carole P.	-	4	13	3	20	-	325	553	73	951
Fuchs, Marc	-	-	4	16	20	-	-	36	64	100
Burr, Thomas J.	3	8	3	4	18	32	176	10	5	223
Walker, M Andrew	4	4	7	1	16	35	59	136	2	232
Lamuela-Raventos, Rosa M.	4	7	3	1	15	502	1280	49	16	1847
Martelli, Giovanni P.	2	2	5	4	13	63	32	53	113	261
Davis, R.E.	3	4	5	1	13	185	77	77	7	346
Boulton, Roger B.	2	3	5	2	12	22	34	92	4	152
Kovacs, Laszlo G.	3	-	1	7	11	58	-	1	21	80
Edwards, Charles G.	-	6	2	2	10	-	128	14	15	157
This, Patrice	-	1	3	6	10	-	138	290	180	608
Vigne, Emmanuelle	-	-	1	9	10	-	-	14	37	51
Noble, A.C.	3	4	3	-	10	83	101	48	-	232
Gonsalves, D.	3	2	4	1	10	71	46	42	6	165
Bertelli, Alberto A.E.	-	2	4	4	10	-	288	151	80	519
Demangeat, Gerard	-	-	1	8	9	-	-	14	15	29
Intrigliolo, Diego S.	-	-	-	9	9	-	-	-	38	38
Sule, Sandor	3	4	1	1	9	38	51	4	1	94
Frankel, E.N.	-	8	1	-	9	-	809	11	-	820
Credi, R.	7	1	1	-	9	218	9	14	-	241
Barka, Essaid Ait	-	-	6	3	9	-	-	518	42	560
Bertelli, A.	-	2	4	3	9	-	288	223	55	566
Fidelibus, Matthew W.	-	-	2	6	8	-	-	10	13	23
Rowhani, Adib	2	4	1	1	8	23	74	2	5	104
Maulik, Nilanjana	-	1	4	3	8	-	73	112	70	255
Velasco, Riccardo	-	-	-	8	8	-	-	-	425	425
Tosaki, Arpad	-	-	5	3	8	-	-	166	47	213
Di Gaspero, Gabriele	-	-	-	7	7	-	-	-	128	128
Lemaire, Olivier	-	-	-	7	7	-	-	-	15	15
Reisch, Bruce I.	2	3	-	2	7	44	155	-	28	227
Minafra, Angelantonio	3	2	-	2	7	84	40	-	9	133
Mortimer, R.K.	2	5	-	-	7	131	185	-	-	316
Cortesi, P.	-	4	2	1	7	-	60	28	2	90
Mills, David A.	-	-	4	3	7	-	-	128	252	380
Smart, David R.	-	-	6	1	7	-	-	66	8	74
Szegedi, Erno	-	2	1	4	7	-	16	4	9	29
Spencer, Robert G.M.	-	-	-	7	7	-	-	-	117	117
Troggio, Michela	-	-	-	7	7	-	-	-	286	286
Kikkert, Julie R.	2	2	-	2	6	44	78	-	28	150
Komar, Veronique	-	-	1	5	6	-	-	14	16	30
Dangl, G.S.	-	-	5	1	6	-	-	322	1	323
Boursiquot, J.M.	1	1	3	1	6	15	138	132	3	288
Forneck, A.	-	3	3	-	6	-	44	25	-	69
Vezzulli, Silvia	-	-	-	6	6	-	-	-	219	219
Das, Samarjit	-	-	1	5	6	-	-	46	102	148
Kocsis, L.	-	2	4	-	6	-	19	43	-	62
Ebeler, Susan E.	-	1	4	1	6	-	14	182	10	206
Lakso, Alan N.	2	-	-	4	6	57	-	-	13	70
Polsinelli, M.	2	4	-	-	6	131	156	-	-	287
Pindo, Massimo	-	-	-	6	6	-	-	-	245	245
Jones, G.V.	-	-	2	4	6	-	-	54	52	106
Meyer, A.S.	-	5	1	-	6	-	523	11	-	534
Balestrieri, Maria Luisa	-	-	-	6	6	-	-	-	47	47
Bagchi, D.	-	-	5	1	6	-	-	218	41	259
Napoli, Claudio	-	-	-	6	6	-	-	-	68	68

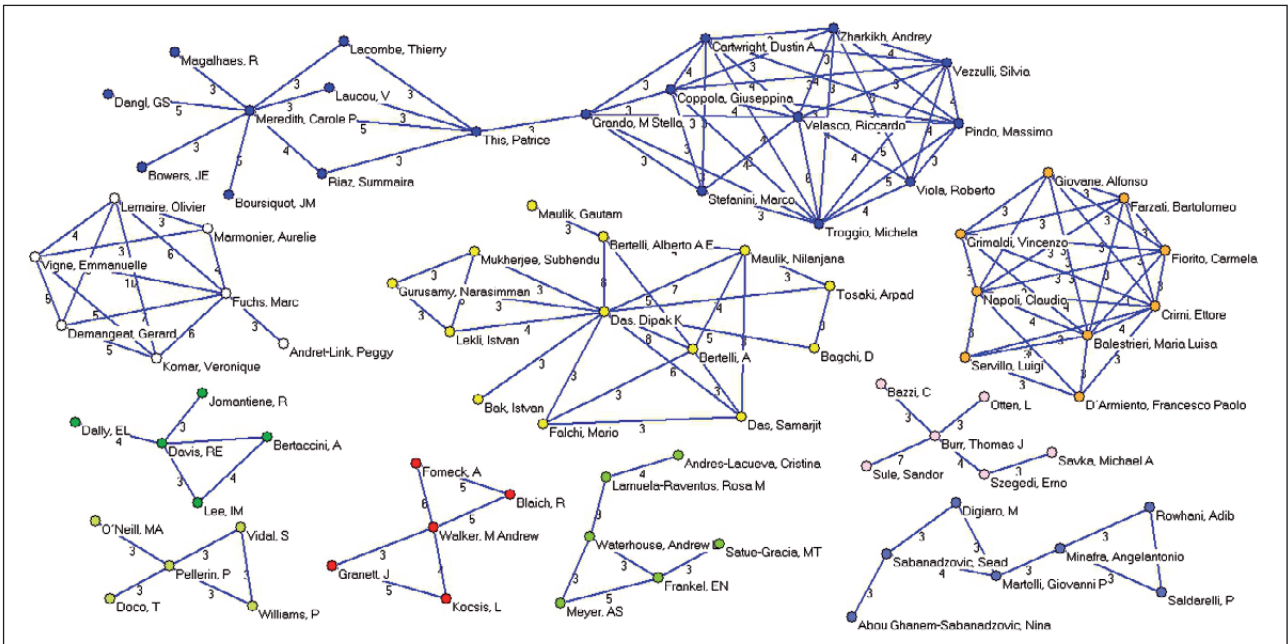


Fig. 2 - Author's network (1).

members, Das was the central author and was linked to 11 other authors. Fig. 2 also presents a group of 9 components, for which the central authors were Balestrieri and Crimi, and other smaller groups: two with seven members, two with six members and three with five members.

Fig. 3 represents the collaborative relationships between institutions. A threshold of three co-authored signed articles was established. The University of California Davis is situated in a central position in the network, and its most intense collaborations have been with the Institute Nation-

ale de la Recherche Agronomique (France), with 16 articles signed jointly, and the University of Barcelona (Spain), with 13 articles. Other centres that occupy a central, although less intense, position are Cornell University (US), with 16 articles signed jointly with the Institute Nationale de la Recherche Agronomique and 10 with the University of Strasbourg; the University of Connecticut, with 12 papers signed in collaboration with the University of Milan; the Agricultural Research Service-United States Department of Agriculture (US); the University of Bologna (Italy); Consiglio

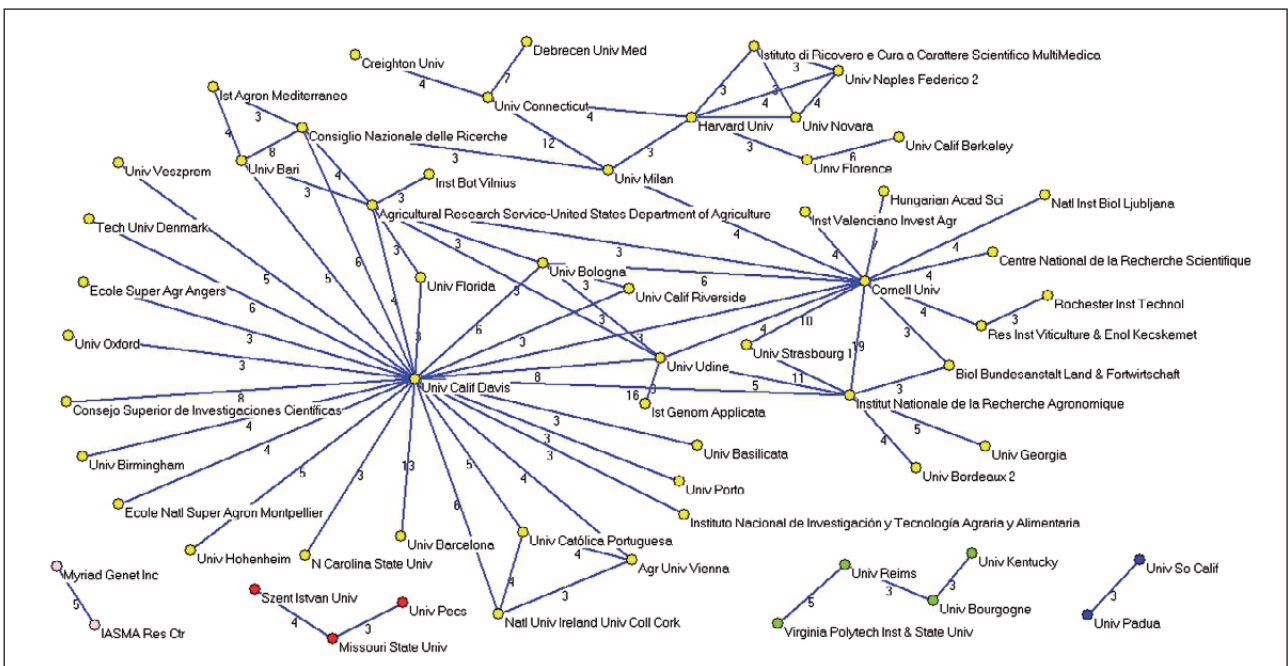


Fig. 3 - Institutions network.

Table 5 - Hot papers (more than 100 citations).

Authors	Title	Journal	Year	Vol.	Iss. Page	First Page	Last Cites	No.
Singleton V.L.; Orthofer R.; Lamuela-Flavento R.M.	Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent in Enzymology	Flavonoids and other Polyphenols Methods Folin-Ciocalteu reagent in Enzymology	1999	299		152	178	1123
Gil M.I.; Tomas-Barberan F.A.; Hess-Pierce B.; Holcroft D.M.; Kader A.A.	Antioxidant activity of pomegranate juice and its relationship with phenolic composition and processing	Journal of Agricultural and Food Chemistry	2000	48	10	4581	4589	340
Rimm E.B.; Katan M.B.; Ascherio A.; Stampfer, M.J.; Willett W.C.	Relation between intake of flavonoids and risk for coronary heart disease in male health professionals	Annals of Internal Medicine	1996	125	5	384	389	315
Teissedre P.L.; Franke E.N.; Waterhouse A.L.; Peleg H.; German J.B.	Inhibition of in vitro human LDL oxidation by phenolic antioxidants from grapes and wines	Journal of the Science of Food and Agriculture	1996	70	1	55	61	287
Makarova K.; Slesarev A.; Wolf Y.; Sorokin A.; Mirkin B.; Koonin E.; et al.	Comparative genomics of the lactic acid bacteria	Proceedings of The National Academy of Sciences of the United States of America	2006	103	42	15611	15616	250
Ray P.S.; Maulik G.; Cordis G.A.; Bertelli .A.A.E.; Bertelli A.; Das D.K.	The red wine antioxidant resveratrol protects isolated rat hearts from ischemia reperfusion injury	Free Radical Biology And Medicine	1999	27	1-2	160	169	215
Rahman I.; Biswas S.K.; Kirrkham P.A.	Regulation of inflammation and redox signaling by dietary polyphenols	Biochemical Pharmacology	2006	72	11	1439	1452	198
Lee I.M.; Bertaccini A.; Vibio M.; Gundersen D.E.	Detection of multiple phytoplasmias in perennial fruit-trees with decline symptoms in Italy	Phytopathology	1995	85	6	728	735	186
Velasco R.; Zharkikh A.; Troggo M.; Cartwright D.A.; Cestaro A.; Pruss D.; et al.	A high quality draft consensus sequence of the genome of a heterozygous grapevine variety	Plos One	2007	2	12	0	0	173
Tapiero H.; Tew K.D.; Ba G.N.; Mathe G.	Polyphenols: do they play a role in the prevention of human pathologies?	Biomedicine & Pharmacotherapy	2002	56	4	200	207	165
Compant S.; Duffy B.; Nowak J.; Clement C.; Barka E.A.	Use of plant growth-promoting bacteria for biocontrol of plant diseases: Principles, mechanisms of action, and future prospects	Applied And Environmental Microbiology	2005	71	9	4951	4959	163
Lamuela Raventos R.M.; Romero Perez A.I.; Waterhouse A.I.; De La Torre Boronat M.C.	Direct hplc analysis of cis-resveratrol and trans-resveratrol and piceid isomers in Spanish red vitis-vinifera wines	Journal Of Agricultural And Food Chemistry	1995	43	2	281	283	162
Kris-Etherton P.M.; Hecker K.D.; Bonanome A.; Coval S.M.; Binkoski A.E.; Hilpert K.F.; et al.	Bioactive compounds in foods: Their role in the prevention of cardiovascular disease and cancer	American Journal of Medicine	2002	113		71	88	158

Table 5 - Continues.

Authors	Title	Journal	Year	Vol.	Iss. Page	First Page	Last Cites	No.
Lamuela Raventos R.M.; Waterhouse A.L.	A direct hplc separation of wine phenolics	American Journal of Enology and Viticulture	1994	45	1	1	5	156
Meyer A.S.; Yi O.S.; Pearson D.A.; Waterhouse A.L.; Frankel E.N.	Inhibition of human low-density lipoprotein oxidation in relation to composition of phenolic antioxidants in grapes (<i>Vitis vinifera</i>)	Journal Of Agricultural and Food Chemistry	1997	45	5	1638	1643	146
Meyer A.S.; Heinson M.; Frankel E.N.	Antioxidant interactions of catechin, cyanidin, caffeic acid, quercetin, and ellagic acid on human LDL oxidation	Food Chemistry	1998	61	1-2	71	75	142
Bowers J.; Boursiquot J.M.; This P.; Chu K.; Johansson H.; Meredith C.	Historical genetics: The parentage of chardonnay, gamay, and other wine grapes of Northeastern France	Science	1999	285	5433	1562	1565	138
Manach C.; Donovan J.L.	Pharmacokinetics and metabolism of dietary flavonoids in humans	Free Radical Research	2004	38	8	771	785	133
M.W.; Xu S.Q.; Maitland-Toolan K.A.; Zuccollo A.; Hou X.Y.; Jiang B.B.; et al.	Polyphenols stimulate AMP-activated protein kinase, lower lipids, and inhibit accelerated atherosclerosis in diabetic LDL receptor-deficient mice	Diabetes	2006	55	8	2180	2191	129
Prince J.P.; Davis R.E.; Wolf T.K.; Lee I.M.; Mogen B.D.; Dally E.L.; et al.	Molecular-detection of diverse mycoplasma-like organisms (miols) associated with grapevine yellows and their classification with aster yellows, x-disease, and elm yellows miols	Phytopathology	1993	83	10	1130	1137	123
Tomas-Barberan F.A.; Gil M.I.; Cremin P.; Waterhouse A.L.; Hess-Pierce B.; Kader A.A.	HPLC-DAD-ESIMS analysis of phenolic compounds in nectarines, peaches, and plums	Journal of Agricultural and Food Chemistry	2001	49	10	4748	4760	122
Meyer A.S.; Donovan J.L.; Pearson D.A.; Waterhouse A.L.; Frankel E.N.	Fruit hydroxycinnamic acids inhibit human low-density lipoprotein oxidation <i>in vitro</i>	Journal of Agricultural and Food Chemistry	1998	46	5	1783	1787	117
Mortimer R.K.; Romano P.; Suzzi G.; Poinelli M.	Genome renewal - a new phenomenon revealed from a genetic-study of 43 strains of saccharomyces-cerevisiae derived from natural fermentation of grape musts	Yeast	1994	10	12	1543	1552	115
This P.; Jung A.; Boccacci P.; Borrego J.; Botta R.; Costantini L.; et al.	Development of a standard set of microsatellite reference alleles for identification of grape cultivars	Theoretical And Applied Genetics	2004	109	7	1448	1458	113
Cavalleri D.; Townsend J.P.; Hartl D.L.	Manifold anomalies in gene expression in a vineyard isolate of <i>Saccharomyces cerevisiae</i> revealed by DNA microarray analysis	Proceedings of the National Academy of Sciences of the United States of America	2000	97	22	12369	12374	104
Pellerin P.; Doco T.; Vidal S.; Williams P.; Brillouet J.M.; O'Neill M.A.	Structural characterization of red wine rhamnogalacturonan II	Carbohydrate Research	1996	290	2	183	197	104
Donovan J.L.; Meyer A.S.; Waterhouse A.L.	Phenolic composition and antioxidant activity of prunes and prune juice (<i>Prunus domestica</i>)	Journal of Agricultural and Food Chemistry	1998	46	4	1247	1252	101

nal of Plant Pathology), microbiology and biotechnology (Applied and Environmental Microbiology, Journal of Applied Microbiology), and health sciences (Journal of Cardiovascular Pharmacology), among others. This diversity of subject areas should alert researchers seeking information on viticulture and oenology to not only investigate the specific journals in this area but to expand their search to other related journals, such as those identified in this study (KLEIN, 1996).

The University of California Davis takes a leadership role in the collaboration with European Union Countries in this area, mainly through the departments of Viticulture and Enology, Plant Sciences, Plant Pathology and Microbiology. The goal of the UC Davis Viticulture and Enology Department is to develop a knowledgeable workforce to form the basis of the state's wine industry and to make California wine more approachable to consumers. Although the program dates back 120 years, the current UC Davis Department of Viticulture and Enology was established in 1935. Many disciplines are studied in the department's complex curriculum. One of the department's innovations was emphasising communication between the vineyard and the winery. This communication effectively bridged the gap that had developed in California between grape growing and winemaking. At Cornell University, several departments have participated, mainly the Department of Plant Pathology & Plant Microbe Biology, the Department of Food Science & Technology and the Department of Ecology & Evolutionary Biology.

The existence of many Italian, French and Spanish institutions that collaborate with the US is not surprising, for two reasons. The first reason is that these Countries are the most important producers of wine in Europe and, consequently, have developed an important research structure in this area. The second reason is that it is very common among European researchers to maintain contact and active research collaborations with many national and international universities and research organisations from the United States. This collaboration involves agreements related to the exchange of students and foreign researchers as well as many collaborative research projects. The promotion of residency in foreign research centres is considered crucial for promoting the internationalisation of science in any Country (PONDS, 2009), and the United States is one of the preferred destination Countries for European researchers. In this work, we have seen a steady increase in collaboration within this area, consistent with the data provided by GLÄNZEL and VEUGELELRS (2006). This study identified other non-American and European institutions that collaborated in the retrieved papers, usually from Countries that also have a tradition of wine production, mainly Australia and South Africa (ALEIXANDRE-BE-NAVENT *et al.*, 2012). With regard to indicators, particularly citation impact indicators, they

should be carefully interpreted because may fail to compare large and small institutions or nations (COSTAS *et al.*, 2009; KATZ, 2000).

Regarding the authors of published articles, the top producer of collaborative articles was Das, who is currently a researcher at the University of Connecticut (Cardiovascular Research Center, School of Medicine, Farmington, Usa). This researcher specialises in wine and health and focuses on the beneficial effects of resveratrol, a red wine- and grape-derived polyphenolic antioxidant that prevents cardiovascular diseases. Waterhouse is a professor in the Department of Viticulture & Enology of the University of California Davis, specialising in research on the health and taste effects of phenolics and other components of wine and their antioxidant activity. The main line of research of Meredith, who also belongs to the Department of Viticulture & Enology at the University of California Davis, is genetics in grape species.

This study identified the research front in the collaboration between the US and the EU in this area by applying social network analysis because this method allowed us to detect the main groups of researchers with scientific collaborations (GEORGHIOU, 1998; GLÄNZEL and SCHUBERT, 2004). Knowledge of these groups has several advantages for researchers. First, it provides researchers with trustworthy information about existing teams that have high research activity. This information provides the opportunity to expand researchers' networks and to participate in discussion forums and exchanges of ideas on significant topics (GONZÁLEZ-ALCAIDE *et al.*, 2008; SCOTT, 2001; WAGNER and LEYDESDORFF, 2005). Second, this knowledge allows researchers to determine which organisations work together and which ones occupy central places in the network, which is helpful in choosing which institutions may be suitable for collaborative activities and multicentre studies. Some authors argue that collaborative networks with many links are preferentially selected by new research groups to begin scientific relationships, and a group rich in connections will increase its influence more quickly due to its leading role in this area (WAGNER and LEYDESDORFF, 2005). As an additional advantage, collaboration between teams with analogous interests and research topics prevents repetition of experiments, increasing research effectiveness (BARABÁSI, 1999; FIGG *et al.*, 2006; GEORGHIOU, 1998; TEASLEY and WOLINSKY, 2001). Smaller groups consisting of a small number of authors with no links to other groups may reflect teams at the beginning of their research activity in this area (BEAVER, 2001; MERRILL and HRIPCSAK, 2008; SAEGUSA, 1999).

Some of the following limitations of this study should be discussed:

1. The SCIE database does not incorporate all published scientific papers on viticulture and oenology, and other complementary sources of in-

formation could have been used. Nevertheless, the use of SCIE has several advantages:

a) SCIE is extensively used in studies investigating scientific activity in science and technology because it includes the highest-impact international journals. Consequently, the use of SCIE allows us to focus on the most important researchers and organisations. b) SCIE provides all of the authors who signed the papers and all of their institutional affiliations, allowing us to obtain indicators of collaboration between authors and institutions. c) SCIE provides the number of citations received by the articles, allowing us to determine the number of citations for their authors and institutions. d) The additional resource JCR provides the impact factor of journals, information not usually present in other databases.

2. The social network analysis based on co-authorship of scientific papers has only recently been employed. For this reason, we have not found similar papers in the scientific literature that analyse the social networks for viticulture and oenology to explain these results.

3. The papers, authors and groups identified in this study did not allow us to examine their contributions to the development and dissemination of knowledge beyond their citations in later publications (GARFIELD, 2006).

CONCLUSIONS

This study offers indicators to measure the state and evolution over the past 20 years of collaborative research in viticulture and oenology between United States of America and the European Union based on articles published in the high-impact international scientific journals included in the SCIE database. This study identified the journals, subject areas, scientific productivity and impact of researchers and organisations. Collaboration patterns between these researchers and organisations were also established, identifying those that were most significant, central and connected to one another. We note a considerable increase in collaboration in recent years, with American, French, Italian and Spanish institutions leading this collaboration. Future lines of research could analyse the behaviour and changes of the identified groups, the increase or decrease in the number of researchers in each group, the quality of published papers based on the number of citations received, and emerging groups and their evolution.

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