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Global research output on date palm (*Pheonix dactylifera*): a 12 years scientometric perspective

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Abstract Date palm (*Phoenix dactylifera*) is one of the commonly used polyphenolic rich fruits attributing also to various therapeutic effect in different diseases and disorders. We aimed to study and analyse the global research output related to date palm based on a fact of its large consumption and production in Middle East. We analysed 1,376 papers obtained from SCOPUS database for the period of 2000–11. The study examines major productive countries and their citation impact. We have also analysed inter-collaborative linkages, national priorities of date palm research, besides analysing the characteristics of its high productivity institutions, authors and journal.

Keywords Date palm · *Phoenix dactylifera* · Plant species · Publications · Scientometrics

Introduction

Plants have always been a major source of food, nutrition and health care for both humans and animals since times immemorial. The date palm (*Phoenix dactylifera*) is a monocotyledon of the family of the Palmae, one of the genera of which is the Coryphoideae, of which one species is *P. dactylifera*. It is a feather palm, characterized by compound leaves with a series of leaflets on each side of a common petiole, originating from one growing point on top of the trunk (Bareveld 1993). Date palm (*P. dactylifera* L.) is a dioecious fruit

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tree native to the hot arid regions of the world, mainly grown in the Middle East and North Africa. Through germplasm exchange, date palm agriculture has expanded to Australia, Southern Africa, India South America, Mexico and the United States of America. Since ancient time, this majestic plant has been recognized as the "tree of life" because of its integration in human settlement, well being and food security in hot and barren parts of the world, where only a few plant species can flourish. Date palm trees continue to provide the most sustainable agro-ecosystems in harsh dry environments (Jain et al. 2011).

Date palms produce many products that are useful to humans. The primary product is the date fruit, which can be eaten fresh, dried, or in various processed forms. Date fruit are available in different forms, including whole pitted and unpitted, dehydrated pieces, diced, extruded date pieces, and macerated fruit. Dates can be used in cereal, pudding, bread, pressed cakes, cookies, candy bars, ice cream, and date shakes. Date fruit also can be made into juice, vinegar, wine, beer, sugar, syrup, honey, chutney, pickle, paste and food flavoring. Date fruit are high-energy food sources with 72–88 % sugar content at maturity. During the Khalal stage, nearly all (80–85 %) of the sugar is sucrose. As ripening progresses, the sucrose is hydrolyzed into reduced sugars such as glucose and fructose. Date fruit are good sources of iron and potassium; a fair source of calcium, chlorine, copper, magnesium and sulfur; and also a minor source of phosphorus. In addition, dates are a source of 16 amino acids and vitamins A, B_1, and B_2 (Chao et al. 2007).

Practically all parts of the date palm, except perhaps the roots, are used for a purpose best suited to them. The main division of date palm parts is made as follows: (a) the trunk, (b) the leaves (whole leaves, midribs, leaflets and spines, and the sheath at the leaf base), (c) the reproductive organs (spathes, fruit stalk, spikelets and pollen) and (d) a number of palm extracts (FAO 2012).

The date palm is used as an ornamental specimen plant in subtropical and tropical climates. The fruit of the date palm contains tannin, which makes it an effective astringent. The fruit from this tree has been used to treat sore throats, colds, bronchial catarrh, fevers, gonorrhea, edema and abdominal problems. The seeds from the tree have been grounded into a paste that is effective in treating ague. Toothaches have been relieved by date palm roots. Finally, gum extracted from the trunk of this tree has effectively been used to treat diarrhea and urinary ailments. The seeds produced by the date palm have been used as food for horses, cattle, camels, sheep and goats. Once ground, they can be used to feed chickens as well. The oils contained within the seeds make them a useful ingredient in cosmetics and soaps. The seeds can also be burned to make charcoal. The chemical composition of the seeds allows them to be used to create oxalic acid. In addition, it is also used as raw materials for construction of houses, household goods and paper, furnishings, and many handcrafts (eHOW 2012).

The annual world production of dates in 2010 was approximately 7.9 million mt according to FAO (http://faostat.fao.org). The major bulk of date palm production, about 68 % of the total world production, comes from Egypt, Saudi Arabia, Iran, United Arab Emirates, Pakistan, Algeria and Iraq. In Saudi Arabia, over 200 date palm cultivars are grown and produce 1,078,000 mt of dates, which is about 14 % of the total world date production (Jain 2012).

Literature review

Anwar carried out a bibliometric analyses of 2,600 publications from 1965 to 2004 on *P. dactylifera* L, derived from all relevant databases and important catalogues available in United States libraries. The study analyzed growth of literature, author patterns, tropical focus, language dispersal and geographical origin of literature on date palm (Anwar 2006).

Similar studies have been carried out on other plant species, namely Oryza (*Oryza sativa* L) by Ramesh and Nagaraj (2000), *Azadirachta indica* by Vijay Kumar, Shehbaz and Naqvi (2002), *Nigella sativa* by Anwar (2005), Podophyllotoxin by Shri Ram (2010) and Artemsia (*Artemisia annua*) by Shri Ram (2011), which are used for medical and other industrial uses.

Objectives

The objective of current analysis is to identify 12 years research trend on *P. dactylifera* (date palm), with a aim: (i) to study global research trends and output related to date palm; (ii) to identify contribution and citation impact of most productive countries related to date palm research; (iii) to study the share of international collaboration papers in research output and inter-country collaborative linkages among leading countries on date palm; (iv) to analyze the contribution and impact of most productive major research institutions and authors publishing on date palm and (v) to identify and study the contribution of most productive journals on date palm.

Materials and methods

This study is based on the world publication data on date palm retrieved from the Scopus Citation database [http://www.scopus.com/search/] for the 12 years (2000–11). The main string used to retrieve the data on date palm was as follows:

(TITLE-ABS-KEY("phoenix dactylifera*") OR TITLE-ABS-KEY("dates(fruits)") OR TITLE-ABS-KEY(("dates" same "fruits")) OR TITLE-ABS-KEY("date palm")) AND PUBYEAR > 1999 AND PUBYEAR < 2012.

For searching data on different countries, the following string was used:

(TITLE-ABS-KEY("phoenix dactylifera*") OR TITLE-ABS-KEY("dates(fruits)") OR TITLE-ABS-KEY(("dates" same "fruits")) OR TITLE-ABS-KEY("date palm")) AND PUBYEAR > 1999 AND PUBYEAR < 2012 AND (LIMIT-TO(AFFIL-COUNTRY,"Saudi Arabia")).

To search information on different subject fields, the following string was used:

(TITLE-ABS-KEY("phoenix dactylifera*") OR TITLE-ABS-KEY("dates(fruits)") OR TITLE-ABS-KEY(("dates" same "fruits")) OR TITLE-ABS-KEY("date palm")) AND PUBYEAR > 1999 AND PUBYEAR < 2012 AND (LIMIT-TO(SUBJ-AREA,"AGRI")).

For citations data, three years, two year and one year citation window has been used for computing average citations per paper on date palm research during 2000–09, 2010, 2011. For analyzing international collaborative papers, institutional, individual and journals output, separate search strategies for generating international collaborative papers, institutional, author and journal outputs were developed to generate the desired output.

Normally raw counts of publications are confounded by the size of the country or institution and the size of the subject field. In order to overcome this problem, we have used an index, called activity index (AI), initially proposed and used by Schubert et al. (1985).

The AI is computed as follows:

$$AI(i,j) = \left(n_{ij}/\ n_{io}\right)/\left(n_{oj}/\ n_{oo}\right),$$

where i indexes the rows (countries) and j indexes the columns (research fields) in the data matrix. N_{ij} = number of publications by country i in field j; N_{io} = number of publications by country i in all field; N_{oj} = number of publications by all countries in field j; N_{oo} = total number of publications by all countries in all fields;AI indicates whether a particular field in under-represented or over-represented in a given country.

Analysis

World output and citation impact

The world publications output on date palm has increased from 44 papers in 2000 to 221 papers in 2011, witnessing an annual average growth rate of 19.46 %. The cumulative publications output on date palm has increased from 354 papers during 2000–05 to 1022 papers during 2006–11, experiencing a growth rate of 188.70 %. The average citation impact per paper (measured on a three year citation window) of total papers on date palm during 2000–11 was 2.79, which has decreased from 2.87 during 2000–05 to 2.76 during 2006–11 (Table 1).

Contribution and citation impact of leading countries

Among the leading countries contribution to world date palm research during the last 12 years from 2000 to 11, the largest share (12.50 %) is contributed by Saudi Arabia, followed by USA (11.34 % share), Tunisia (8.14 % share), Egypt (7.63 % share), Iran, France, Spain and Morocco (with publication share from 5.23 to 6.98 %), United Arab Emirates, India, UK, Oman, Israel and Italy (with publication share from 3.05 to 4.72 %).

Table 1 World publications output and citations impact on date palm, 2000–2011

Publication year	Total papers	Total citations	Average citations per paper
2000	44	92	2.09
2001	49	96	1.96
2002	60	162	2.70
2003	61	134	2.20
2004	61	217	3.56
2005	79	316	4.00
2006	83	256	3.08
2007	140	484	3.46
2008	128	562	4.39
2009	158	655	4.15
2010	292	563	1.93
2011	221	301	1.36
2001–05	354	1,017	2.87
2006–11	1,022	2,821	2.76
2001–11	1,376	3,838	2.79

The date palm research has increased by 6.35 % in Iran, 4.11 % in Tunisia, 2.18 % in United Arab Emirates, 1.53 % in Egypt, 1.24 % in Saudi Arabia, 1.20 % in Spain and 0.69 % in Italy, as against decrease by 5.77 % in UK, 4.89 % in USA, 2.84 % in Morocco, 0.79 % in India, 0.69 % in France, 0.64 % in Israel and 0.35 % in Oman from 2000–05 to 2006–11. In terms of citation impact, 8 countries out of 14 have scored more than the average citation impact (2.79) of the world, with highest citation impact (4.98) being registered by Italy, followed by Spain (4.74), UK (4.57), USA (4.38), Tunisia (4.22), France (4.10), Morocco (3.44) and Israel (3.25) (Table 2).

International collaboration

The share of international collaborative papers of 14 leading countries on date palm research varies from 8.33 to 89.13 % during 2000–11, with largest share (89.13 %) coming from UK, followed by France (76.60 %), Tunisia (58.93 %), Morocco (52.78 %), Italy (52.38 %), United Arab Emirates (47.69 %), USA (46.79 %),Spain (45.56 %), Egypt (40.95 %), Oman (38.30 %), Saudi Arabia (29.65 %), Israel (25.00 %), India (20.69 %) and Iran (8.33 %) (Table 3).

Among the international collaborative linkages between the 14 leading countries on date palm, the largest number (72) comes from France, followed by USA (58), Tunisia (48), Spain (47), UK (45), Egypt (39), Morocco (39), UAE (26), Italy (25), Oman (13), India (12), Iran (8) and Israel (3). The largest number of inter-collaborative international linkages (24) was between Saudi Arabia–Egypt, followed by France–Tunisia (23), France–Morocco (22),

Table 2 Contribution and citation impact of leading countries on date palm, 2000–2011

S. no	Country	Number of papers			Share of papers			Total citations	ACPP
		2000–05	2006–11	2000–11	2000–05	2006–11	2000–11	2000–11	2000–11
1.	Saudi Arabia	41	131	172	11.58	12.82	12.50	269	1.56
2.	USA	53	103	156	14.97	10.08	11.34	684	4.38
3.	Tunisia	18	94	112	5.08	9.20	8.14	473	4.22
4.	Egypt	23	82	105	6.50	8.02	7.63	214	2.04
5.	Iran	8	88	96	2.26	8.61	6.98	130	1.35
6.	France	26	68	94	7.34	6.65	6.83	385	4.10
7.	Spain	20	70	90	5.65	6.85	6.54	427	4.74
8.	Morocco	26	46	72	7.34	4.50	5.23	248	3.44
9.	United Arab Emirates	11	54	65	3.11	5.28	4.72	138	2.12
10.	India	17	41	58	4.80	4.01	4.22	87	1.50
11.	UK	27	19	46	7.63	1.86	3.34	210	4.57
12.	Oman	13	34	47	3.67	3.33	3.42	105	2.23
13.	Israel	13	31	44	3.67	3.03	3.20	143	3.25
14.	Italy	9	33	42	2.54	3.23	3.05	209	4.98
	World	354	1,022	1,376	100.0	100.0	100.0	3,838	2.79

ACPP average citation per paper

Table 3 Share of international collaborative papers on date palm in leading countries, 2000–2011

Country	Total papers	Total international collaborative papers	Share of international collaborative papers
Saudi Arabia	172	51	29.65
USA	156	73	46.79
Tunisia	112	66	58.93
Egypt	105	43	40.95
Iran	96	8	8.33
France	94	72	76.60
Spain	90	41	45.56
Morocco	72	38	52.78
United Arab Emirates	65	31	47.69
India	58	12	20.69
UK	46	41	89.13
Oman	47	18	38.30
Israel	44	11	25.00
Italy	42	22	52.38

USA–UK (10), Italy–Spain (9), USA–UAE (8), Spain–France (8), USA–France (7), UK–UAE (7), Saudi Arabia–USA (6), Morocco–Tunisia (6), Spain–UK (6), etc. (Table 4).

Date palm research output in context of different sub-fields

The world's publication output on date palm during 20001–11 has been published in context of 10 sub-fields (as reflected in database classification, based on journal subject classification as defined in scopus database), with highest publications output coming from agricultural and biological sciences (961 papers and 69.84 % publications share), followed by biochemistry, genetics and molecular biology (189 papers and 13.74 % publications share), environment science (149 papers and 10.83 % publications share), medicine (116 papers and 8.43 % publications share), chemistry (101 papers and 7.34 % publications share), immunology and microbiology (70 papers and 5.09 % publications share), materials science (49 papers and 3.56 publications share) and pharmacology, toxicology and pharmaceutics (35 papers and 2.54 % publications share). On normalizing the world publication output data using activity index, it was observed that the activity has increased in agricultural and biological sciences (from 93.43 to 102.27) and pharmacology, toxicology and pharmaceutics (from 77.74 to 107.71), as against decrease in biochemistry, genetics and molecular biology (from 121.34 to 92.61), environment science (from 104.35 to 98.49), medicine (from 130.68 to 89.37), chemistry (from 127.00 to 90.65), immunology & microbiology (from 122.16 to 92.32) and materials science (from 105.72 to 82.43) (Table 6). On analyzing the quality and impact of date palm research output under different sub-fields, it was found that immunology & microbiology had scored the highest impact (4.54 citations per paper), followed by pharmacology, toxicology and pharmaceutics (4.03 citations per paper), materials science (4.02 citations per paper),

Table 4 Inter-collaborative linkages amongst leading countries on date palm, 2000–2011

Country	SAB	USA	TUNIS	EGYP	IRAN	FR	SPA	MOR	UAE	IND	UK	OMAN	ISR	ITAL	Total
SAB		6	1	24		2	1		1	9	3			2	49
USA	6		3	4	2	7	5	4	8	2	10	2	3	2	58
TUNIS	1	3		1		23	10	6			1			3	48
EGYP	24	4	1			1		1	5		2	1			39
IRAN		2				1	3	1			1				8
FR	2	7	23	1	1		8	22			4	1		3	72
SPA	1	5	10		3	8		5			6			9	47
MOR		4	6	1	1	22	5				1				39
UAE	1	8		5						1	7	3			26
IND	9	2							1						12
UK	3	10	1	2	1	4	6	1	7			5		5	45
OMAN		2		1		1			3		5			1	13
ISR		3													3
ITAL	2	2	3			3	9				5	1			25
Total	49	58	48	39	8	72	47	39	26	12	45	13	3	25	484

SAB Saudi Arabia, *TUNIS* Tunisia, *FR* France, *SPA* Spain, *MOR* Morocco, *UAE* United Arab Emirates, *IND* India, *ISR* Israel, *ITAL* Italy

Table 5 Sub-field wise break-up of world date palm research publications, 2000–2011

Broad sub-field	Total publications			Activity index		Total citations	ACPP
	2000–05	2006–11	2000–11	2000–05	2006–11	2000–11	2000–11
Agric. & Biolog. Sci	231	730	961	93.43	102.27	2,312	2.41
Bioc., Genet & Mol. Biology	59	130	189	121.34	92.61	758	4.01
Envi. Sci.	40	109	149	104.35	98.49	466	3.13
Medicine	39	77	116	130.68	89.37	413	3.56
Chemistry	33	68	101	127.00	90.65	378	3.74
Immun. & Microb.	22	48	70	122.16	92.32	318	4.54
Material Science	19	30	49	150.72	82.43	197	4.02
Pharm., Toxic & Pharmaceutics	7	28	35	77.74	107.71	141	4.03
Total of the world	354	1,022	1,376	100.00	100.00		

biochemistry, genetics & molecular biology (4.01 citations per paper), chemistry (3.74 citations per paper), medicine (3.56 citations per paper), etc. (Table 5).

Analyzing the priorities assigned to different subject fields in most productive countries using research output and activity index profile, it was observed that: (i) agricultural and biological sciences has remained the most priority area in most of the countries (with activity index varying from 105.7 to 148.3), except India and Italy (with activity index between 88.9 and 95.5); (ii) biochemistry, genetics and molecular biology, being the second largest output at world level, showed above average activity in most of the countries (with activity index varying from 101.1 to 254.1), except in UAE, Oman, Israel and USA (with activity index varying from 22.4 to 85.1), (iii) environment science, with the third largest output at world level, showed above average activity in most of the countries (with activity index varying from 104.9 to 188.0), except in Spain, Morocco, UK, Italy and Saudi Arabia (with activity index varying from 41.0 to 97.9); (iv) medicine, with the fourth largest output at world level, showed above average activity in most of the countries (with activity index varying from 127.7 to 197.7), except in Morocco, India, Oman, Israel, Egypt and Tunisia (with activity index varying from 16.5 to 96.69); (v) chemistry, with the fifth largest output at world level, showed above average activity in seven countries (with activity index varying from 111.0 to 187.9), except in Iran, Egypt, Spain, UAE, USA, Israel and Italy (with activity index varying from 55.5 to 97.3); (vi) immunology and microbiology, with the six largest output at world level, showed above average activity 8 countries (with activity index varying from 101.7 to 327.6), except in UAE, Oman, Morocco, USA, Israel and Egypt (with activity index varying from 0.0 to 97.6); (vii) materials science, with the seventh largest output at world level, showed below average activity in 9 countries (with activity index varying from 0.0 to 96.8), except in Tunisia, UAE, Morocco, Saudi Arabia and France (with activity index varying from 130.7 to 389.3) and (viii) pharmacology, toxicology and pharmaceutics, with the eighth largest output at world level, showed above average activity in 8 countries (with activity index varying from 131.3 to 474.5), except in UAE, UK, Oman, Italy, Spain and Morocco (with activity index varying from 0.0 to 54.6) (Tables 6, 7).

Table 6 National priorities of date palm research in terms of publications output in leading countries, 2000–2011

Subject	Number of papers														
	SAB	USA	TUNIS	EGYP	IRAN	FR	SPA	MOR	UAE	IND	UK	OMAN	ISR	ITAL	World
Agri	106	118	89	80	68	59	68	59	48	36	44	35	37	28	961
Bioc	27	14	30	13	13	24	20	10	2	9	9	3	4	7	189
Envi	14	17	10	14	15	14	4	4	9	10	3	9	5	3	149
Medi	15	13	7	6	10	8	10	1	7	2	7	2	2	7	116
Chem	15	8	7	4	3	7	5	6	4	8	5	6	3	3	101
Immu	9	4	9	4	9	6	13	1	0	3	4	0	2	7	70
Mate	17	1	4	2	1	10	2	6	4	2	0	0	0	0	49
Phar	7	4	4	3	3	1	0	1	0	7	0	0	2	0	35
Total	172	156	112	105	96	94	90	72	65	58	46	47	44	42	1,376

SAB Saudi Arabia, *TUNIS* Tunisia, *FR* France, *SPA* Spain, *MOR* Morocco, *UAE* United Arab Emirates, *IND* India, *ISR* Israel, *ITAL* Italy, *Agri* Agricultural & Biological Sciences, *Bioc* Biochemistry, Genetics & Molecular Biology, *Envi* Environmental Science, *Medi* Medicine, *Chem* Chemistry, *Immu* Immunology & Microbiology, *Mate* Materials Science, *Phar* Pharmacology, Toxicology & Pharmaceutics

Table 7 National priorities of date palm research in terms of activity index in leading countries, 2000–2011

Subject	Activity index													
	SAB	USA	TUNIS	EGYP	IRAN	FR	SPA	MOR	UAE	IND	UK	OMAN	ISR	ITAL
Agri	115.0	141.1	148.3	142.2	132.2	117.1	108.2	117.3	105.7	88.9	137.0	106.6	120.4	95.5
Bioc	148.9	85.1	254.1	117.5	128.5	242.2	161.8	101.1	22.4	113.0	142.4	46.5	66.2	121.3
Envi	97.9	131.1	107.4	160.4	188.0	179.2	41.0	51.3	127.9	159.2	60.2	176.8	104.9	66.0
Medi	134.8	128.8	96.6	88.3	161.0	131.5	131.8	16.5	127.7	40.9	180.5	50.5	53.9	197.7
Chem	154.8	91.0	111.0	67.6	55.5	132.2	75.7	113.5	83.8	187.9	148.1	173.9	92.9	97.3
Immu	134.0	65.7	205.8	97.6	240.1	163.5	283.9	27.3	0.0	101.7	170.9	0.0	89.4	327.6
Mate	361.7	23.4	130.7	69.7	38.1	389.3	62.4	234.0	172.8	96.8	0.0	0.0	0.0	0.0
Phar	208.5	131.3	183.0	146.4	160.1	54.5	0.0	54.6	0.0	474.5	0.0	0.0	178.7	0.0

SAB Saudi Arabia, *TUNIS* Tunisia, *FR* France, *SPA* Spain, *MOR* Morocco, *UAE* United Arab Emirates, *IND* India, *ISR* Israel, *ITAL* Italy, *Agri* Agricultural & Biological Sciences, *Bioc* Biochemistry, Genetics & Molecular Biology, *Envi* Environmental Science, *Medi* Medicine, *Chem* Chemistry, *Immu* Immunology & Microbiology, *Mate* Materials Science, *Phar* Pharmacology, Toxicology & Pharmaceutics

Contribution and citation impact of leading institutions

The top 15 most productive world institutions involved in date palm research have published 13 and more papers each during 2000–11. The publications profile of these 15 world institutions along with their research output, citations received and h-index values are presented in Table 8. These 15 institutions involved in date palm research together have contributed 29.72 % share (with 409 papers) in the cumulative publications output of world on date palm, with an average of 27.26 papers per institution. Only 7 institutions have produced higher publications output than the group average. These are Universite Cadi Ayyad, Morocco with 43 papers, followed by King Faisal University, Saudi Arabia (41 papers), University of Sfax, Ecole Nationale d'Ingenieurs de Sfax, Tunisia (38 papers), United Arab Emirates University (36 papers), King Saud University, Saudi Arabia (34 papers), National Research Centre, Cairo, Egypt (29 papers) and Agricultural Research Organization of Israel (27 papers).

The average citation per paper registered by the total papers of these 15 institutions is 3.13 during 2000–11. Only 6 institutions have registered higher citation impact than the group average. The highest impact of 6.29 citations per paper was scored by the University of Sfax, Ecole Nationale d'Ingenieurs de Sfax, Tunisia, followed by Universite de Liege, Belgium (5.75 citations per paper), University of California, Riverside, USA (5.11 citations per paper), Universite Cadi Ayyad, Morocco (4.07 citations per paper), Tunis-El Manar University, Tunisia (3.74 citations per paper) and University of Florida, USA (3.46 citations per paper).

Table 8 Productivity and impact of top 15 institutions in date palm research, 2000–2011

S. no.	Name	TP	TC	ACPP	H-Index	ICP	% ICP
1	Universite Cadi Ayyad, Morocco	43	175	4.07	13	32	74.42
2	King Faisal University, Saudi Arabia	41	78	1.90	8	9	21.95
3	University of Sfax, Ecole Nationale d'Ingenieurs de Sfax, Tunisia	38	239	6.29	11	24	63.16
4	United Arab Emirates University, UAE	36	101	2.81	9	11	30.56
5	King Saud University, Saudi Arabia	34	44	1.29	10	5	14.71
6	National Research Centre, Cairo, Egypt	29	64	2.21	7	4	13.79
7	Agricultural Research Organization of Israel	28	80	2.86	6	10	35.71
8	Tunis-El Manar University, Tunisia	27	101	3.74	10	11	40.74
9	Sultan Qaboos University, Oman	26	37	1.42	6	8	30.77
10	King Abdulaziz University, Saudi Arabia	22	41	1.86	4	10	45.45
11	Universite de Liege, Belgium	20	115	5.75	7	19	95.00
12	University of California, Riverside, USA	18	92	5.11	9	4	22.22
13	Agricultural Research Institute, Giza, Egypt	17	31	1.82	3	6	35.29
14	CIRAD Centre de Recherche de Montpellier, France	17	39	2.29	7	13	76.47
15	University of Florida, USA	13	45	3.46	6	4	30.77
	Total of 15 institutions	409	1,282	3.13	7.73	170	41.56
	World output (total of all institutions)	1,376					
	Share of top 15 institutions in world output	29.72					

TP total papers, *TC* total citations, *ACPP* average citations per paper

The average h-index value of these 15 most productive institutions on date palm was 7.73 during 2000–11. The seven institutions have scored higher h-index value than group's average of 7.73. The highest h-index value (13) was achieved by Universite Cadi Ayyad, Morocco, followed by University of Sfax, Ecole Nationale d'Ingenieurs de Sfax, Tunisia (11), Tunis-El Manar University, Tunisia and King Saud University, Saudi Arabia (10 each), University of California, Riverside, USA and United Arab Emirates University, UAE (9 each) and King Faisal University, Saudi Arabia (8).

The average share of international collaborative papers of these top 15 institutions was 41.56 % during 2000–11. The five institutions have scored higher share of international collaborative papers than group's average (41.56 %). The highest share (90.00 %) of international collaborative papers was scored by Universite de Liege, Belgium, followed by CIRAD Centre de Recherche de Montpellier, France (76.47 %), Universite Cadi Ayyad, Morocco (74.42 %), University of Sfax, Ecole Nationale d'Ingenieurs de Sfax, Tunisia (63.16 %) and King Abdulaziz University, Saudi Arabia (45.45 %).

Contribution and citation impact of leading authors

Based on the publication data, 12 authors having been identified who have published 10 and above papers on date palm research during 2000–11. These 12 authors together contributed 192 papers with an average of 16 papers per author and account for 13.95 % share in the cumulative publications output of the world during 2002–11. Six authors have published higher number of papers than the group's average (16). These are: N.E. Drira with 23 papers, followed by H. Attia (22 papers), S. Besbes (21 papers), C.S. Blecker (20 papers), M. Trifi (18 papers) and M. Marrakchi (17 papers). Considering the quality/impact of papers, these 12 most productive authors have received a total of 1013 citations for 192 papers with an average of 5.28 citations per paper during 2000–11. Six authors have registered higher impact than the average impact of papers of all authors (5.28). These are: Hamid Kaddami with 9.90 citations per paper, Claude Deroanne (8.50 citations per paper), N.E. Drira (7.26 citations per paper), C.S. Blecker (5.90 citations per paper), S. Besbes (5.71 citations per paper) and H. Attia (5.64 citations per paper). Measuring the performance of these authors on the basis of h-index, four authors have achieved the higher h-index value than the group's average of 7.25 during 2000–11. These authors are N.E. Drira with h-index of 10, followed by Ismail El-Hadrami (9), M. Trifi (9) and M. Marrakchi (9) (Table 9).

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The 20 most productive journals publishing world research papers on date palm together contributed 482 papers, which accounts for 35.03 % share of the total world output during 2000–11. The cumulative publications output share of these 20 most productive journals showed an increase in world's publications output from 24.01 % during 2000–05 to 38.85 % during 2006–11 (Table 10).

Summary

The world date palm publications have increased from 44 papers to 221 papers from 2000 to 2011, showing an annual average growth rate of 19.46 %. The date palm cumulative publications output has increased from 354 papers to 1,022 papers from 2000–05 to 2006–11, witnessing a growth rate of 188.70 %. In terms of citation impact (measured on a

Table 9 Productivity and impact of twelve most productive authors in date palm research, 2000–2011

S. no.	Name	Institutional affiliation	TP	TC	ACPP	H-index	ICP
1	N.E. Drira	University of Sfax, Ecole Nationale d'Ingenieurs de Sfax, Tunisia	23	167	7.26	10	16
2	H. Attia	University of Sfax, Ecole Nationale d'Ingenieurs de Sfax, Tunisia	22	124	5.64	7	20
3	S. Besbes	University of Sfax, Ecole Nationale d'Ingenieurs de Sfax, Tunisia	21	120	5.71	7	20
4	C.S. Blecker	Universite de Liege, Belgium	20	118	5.90	7	20
5	M. Trifi	Tunis-El Manar University, Tunisia	18	57	3.17	9	6
6	M. Marrakchi	Tunis-El Manar University, Tunisia	17	51	3.00	9	6
7	Ismail El-Hadrami	Universite Cadi Ayyad, Morocco	15	62	4.13	9	7
8	M.A. Awad	United Arab Emirates University	13	43	3.31	4	8
9	Claude Deroanne	Unite de Technologie de Industries Agro-alimentaires, Belgium	12	102	8.50	6	12
10	J.M. Al-Khayri	King Faisal University, College of Agriculture & Food Science, Date Pal Centre, Saudi Arabia	11	43	3.91	7	0
11	A. Rhouma	Tunis-El Manar University, Tunisia	10	27	2.70	7	2
12	Hamid Kaddami	Universite Cadi Ayyad, Morocco	10	99	9.90	5	9
		Total	192	1,013	5.28	7.25	126
		Total of the world	1,376				
		Share of top 12 authors in world total	13.95				

TP total papers, *TC* total citations, *ACPP* average citations per paper

3 years citations window), the average citation impact per paper of the total papers on date palm was 2.79 during 2000–11, decreasing from 2.87 to 2.76 from 2000–05 to 2006–11. The largest contributor to world date palm research was Saudi Arabia with 12.50 % publication share during 2000–11, followed by USA (11.34 % share), Tunisia (8.14 % share), Egypt (7.63 % share), Iran (6.98 % share), France (6.83 % share), Spain (6.54 % share) etc. Among the 14 top publishing countries on date palm, 8 countries have scored more than the average citation impact (2.79) of the world, with highest citation impact (4.98) coming from Italy, followed by Spain (4.74), UK (4.57), USA (4.38), Tunisia (4.22), France (4.10), Morocco (3.44) and Israel (3.25).

Among 14 leading countries, the largest international collaborative papers share (89.13 %) in their research output comes from UK, followed by France (76.60 %), Tunisia (58.93 %), Morocco (52.78 %), Italy (52.38 %), United Arab Emirates (47.69 %), USA (46.79 %), Spain (45.56 %), Egypt (40.95 %), Oman (38.30 %), Saudi Arabia (29.65 %), Israel (25.00 %), India (20.69 %) and Iran (8.33 %). The largest number of inter-country collaborative linkages (72) among the top 14 countries on date palm comes from France, followed by USA (58), Tunisia (48), Spain (47), UK (45), Egypt (39), Morocco (39), UAE (26), Italy (25), Oman (13), India (12), Iran (8) and Israel (3). The largest inter-collaborative linkages (24) was between Saudi Arabia–Egypt, followed by France–Tunisia (23), France–Morocco (22), USA–UK (10), Italy–Spain (9), USA–UAE (8), Spain–France (8), USA–France (7), UK–UAE (7), Saudi Arabia–USA (6), Morocco–Tunisia (6), Spain–UK (6), etc.

Table 10 List of most productive journals publishing world papers on date palm, 2000–11

Name of the Journal	Number of Papers		
	2000–05	2006–11	2000–11
Acta Horticulturae	0	247	247
Scientia Horticulturae	3	21	24
African Journal of Biotechnology	5	18	23
Journal of Horticultural Science and Biotechnology	6	12	18
Food Chemistry	5	12	17
Hortscience	12	5	17
Journal of Agricultural and Food Chemistry	7	9	16
Fruits	2	10	12
Journal of Food Agriculture and Environment	0	11	11
Asian Journal of Chemistry	6	5	11
Biologia Plantarum	6	4	10
Phytoparasitica	6	4	10
Journal of Phytopathology	7	2	9
Bioresource Technology	4	5	9
Florida Entomologist	1	8	9
Postharvest Biology and Technology	3	5	8
Arab Gulf Journal of Scientific Research	3	5	8
International Journal of Food Science and Technology	2	6	8
Plant Disease	6	2	8
Horttechnology	1	6	7
Total of top 20 journals	85	397	482
Total of the world	354	1,022	1,376
Share of top 20 journals in world output	24.01	38.85	35.03

In terms of subject distribution, the largest share (69.84 %) comes from agricultural and biological sciences, followed by biochemistry, genetics & molecular biology (13.74 %), environment science (10.83 %), medicine (8.43 %), chemistry (7.34 %), immunology and microbiology (5.09 % publications share), materials science (3.56 %) and pharmacology, toxicology and pharmaceutics (2.54 %). In terms of citation impact, the largest (4.54 citations per paper) comes from immunology and microbiology, followed by pharmacology, toxicology and pharmaceutics (4.03), materials science (4.02), biochemistry, genetics and molecular biology (4.01), chemistry (3.74), medicine (3.56), etc.

The top 15 most productive institutions on date palm together contributed 29.72 % share (with 409 papers) in the cumulative publications output of world, with an average of 27.26 papers per institution. The average citation per paper, h-index and the average share of international collaborative papers of these top 15 institutions are 3.13, 7.73 and 41.56 %. The top 12 most productive authors on date palm together contributed 13.95 % share (with 192 papers) in the cumulative publications output of world, with an average of 16 papers per author. The average citation per paper and h-index these top 12 authors are 5.28 and 7.25. The 20 most productive journals publishing world research papers on date palm together accounted for 35.03 % share (482 papers) of the total world output during 2000–11, increasing from 24.01 % during 2000–05 to 38.85 % during 2006–11.

Conclusion

For ages, natural products have been affordable therapeutics to the majorities of the less privileged population in developing and underdeveloped nations. The potential of the natural products have attracted the attention of the developed world, to tap their benefits to identify better and safe drugs to combat human diseases, while in the poor nations these products (although in crude form) continue to provide health benefits to the diversified categories of patients. The fact that these plant products are locally grown, make their availability to the once in need and at the same time being very affordable. The common objective of utilizing the scientific knowledge on date palm to design better strategies to improve global health in general and health status of less privileged in the developing and underdeveloped nations. Hence, developing an active lead from date palm, which improves health status or cure diseases and disorders, will definitely have a greater impact on society.

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