

## ACADEMIC CHEMISTRY IN ROMANIA – SOME SCIENTIFIC RESULTS

SILVIU JIPA<sup>1</sup>, LAURA MONICA GORGHIU<sup>1</sup>, CRINELA DUMITRESCU<sup>1</sup>,  
CALIN OROS<sup>1</sup>

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**Abstract.** *The paper analyzes a series of bibliometric indicators related to the research performance of Chemistry professors in different Romanian universities. The total number of ISI papers, total number of citations, number of citations per paper, number of citations per year and Hirsch indices have been used to evaluate their research output. The individual professor's Hirsch-index linearly depends on the scientometric indicators of the journal in "h-core", namely the impact factor, influence score and the journal's Hirsch-index.*

*Keywords: research, Scientometrics, Hirsch index, influence score, impact factor*

### 1. INTRODUCTION

Nowadays, universities are being called upon to respond immediately to the daily challenges raised by human knowledge and activity, their main tasks being the growth and development of scientific research as well as the proposal of viable solutions to the problems of the present Romanian society. For the accomplishment of this goal, the professionalism and quality are primary required values. These values must characterize both the academic staff and the students, both the research and the teaching activity.

The academician Grigore Moisil once said: "We are asked to do productive science and scientific production. It would be much better if we could manage to do scientific science and productive production".

The Romanian Researchers' Association "AdAstra" released the 3<sup>rd</sup> issue of the top national universities in Romania. The rankings are done on the basis of the scientific papers published by the academic staff members in scientific journals that are recognized internationally. In 2011, the first three positions in the universities' ranking are held, in this order, by the University of Bucharest, "Babes-Bolyai" University of Cluj-Napoca and "Alexandru Ioan Cuza" University of Iasi [1, 2].

The papers published in journals with ISI impact factor constitute one of the main factors in evaluating a university's scientific activity and are used for making up the international classification of higher education institutions [3-7].

Several graduates of Chemistry from different Romanian universities have made a bright career as professors and researchers in other universities from the world, as academicians of the Romanian Academy and other academies in the world, ministers, diplomats etc.

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<sup>1</sup> Valahia University of Targoviste, Faculty of Science and Arts, 130024 Targoviste, Romania.  
E-mail: [jipasilviu@yahoo.com](mailto:jipasilviu@yahoo.com).

The current paper presents certain aspects regarding the outstanding scientific performance of some researchers in higher education and research institutes, professors and members of the Romanian Academy. Different indicators like the total number of papers, the total number of citations, the average number of citations per paper, the average number of papers per year, the researcher's Hirsch-index and so on are analyzed. The authors are trying to achieve a direct correlation of the researcher's Hirsch-index with the average Hirsch indices of the academic journals in h-core in which the researchers published the papers.

## 2. EXPERIMENTAL

We have analyzed a number of 91 academic staff members in the field of Chemistry who are professors, academicians, correspondent members of Romanian Academy and main researchers from the perspective of their individual performances in scientific output. These people belong to a number of six Romanian higher education establishments located in the university centers of Bucharest, Cluj-Napoca, Iasi, Timisoara, Craiova and Targoviste. The study has not included technical higher education establishments.

The information on the total number of papers, total number of citations, average number of citations per paper, average number of papers per year, Hirsch-index and so on has been taken from the latest ISI Web of Knowledge Database.

The Hirsch indices of the scientific journals in h-core have been collected from SCImago Journal & Country Rank [8].

The impact factors and the influence scores of the h-core journals are taken from the public documents related to this issue published annually [9].

The h-core has the following significance: it shows the number of citations, from the highest to the one corresponding to the Hirsch-index (Fig. 1).

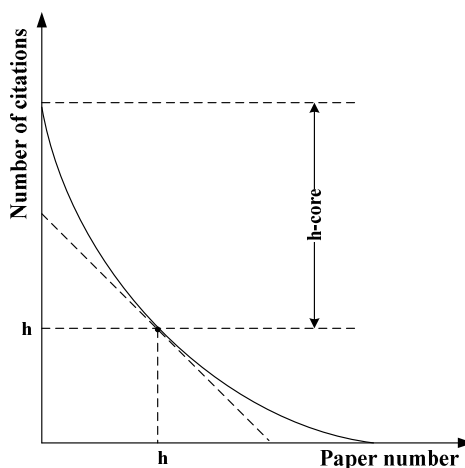


Fig. 1. The significance of h-core.

After the data have been collected, these were averaged for each university. The use of the average value for bibliometric and scientometric measurements is frequently employed [10].

### 3. RESULTS AND DISCUSSIONS

The tables bellow present the mean bibliometric and scientometric values we have considered for the academic members in the Chemistry Faculties under study. The number of citations per paper, a measure that shows the impact of the paper, was found to be an average value of 7.29, very close to 6.04 which was the accreditation value for our country two years ago, for the period 1996-2010 [11].

The same evaluation for other countries indicates values of 20.18 (U.S.A), 17.42 (U.K.), 11.72 (Japan), 15.79 (Germany), 15.09 (France) etc.

If we look at the data given in the table 1, we can notice that the performances of the academic members in the studied universities record a descending trend as shown below:

*University of Bucharest > "Babes-Bolyai" University of Cluj-Napoca > "Alexandru Ioan Cuza" University of Iasi.*

This direction is identical to the one identified by the "AdAstra" Association [1,2] and complies with the Romanian Universities' programmes ranking [12].

**Table 1. The average values of bibliometric/scientometric parameters for some large academic communities of professors in the Chemistry Faculties of some Romanian universities.**

Higher education establishment	No. of persons	Total no. of papers	Total no. of citations	Average citations per paper	Average citations per year	Hirsch index	Scientific productivity: number of papers per year
University of Bucharest	29	161	1648	7.42	39.00	14	4.6
"Babes-Bolyai" University of Cluj-Napoca	27	90	676	5.45	19.18	10	2.8
"Alexandru Ioan Cuza" University of Iasi	24	50	234	4.68	9.22	6	1.6

The data presented in table 2 reveal the existence of an honorable behavior of the academic communities in the respective universities as well as some acceptable mean Hirsch-indices.

**Table 2. The average values of bibliometric/scientometric parameters for some small academic communities of professors in the Chemistry Faculties of some Romanian universities.**

Higher education establishment	No. of persons	Total no. of papers	Total no. of citations	Average citations per paper	Average citations per year	Hirsch index	Scientific productivity: number of papers per year
West University of Timisoara	5	66	703	18.03	23.18	9	2.2
University of Craiova	3	79	257	2.71	8.47	8	3.3
"Valahia" University of Targoviste	3	107	542	5.47	19.81	11	3.6

The above faculties are considered middle from perspective of Romanian Universities' programmes ranking [12]. At the same time, it can be noticed that the Hirsch-index is

characteristically used to rank some smaller or larger groups in accordance with their scientific output.

A researcher's high Hirsch-index is obtained when the former mainly papers are published in valuable scientific journals, with high Hirsch indices. These journals are frequently read and cited therefore they have high Hirsch indices. Although this may sound like an axiom, we have tried to demonstrate its validity experimentally.

We formed a group of scientific personalities and we analyzed the influence of Hirsch indices of the journals in which they had published their papers on the Hirsch index of these personalities. To this effect, we determined the Hirsch indices of the journals in "h-core" (Fig. 1) and we extracted and average (Table 3).

**Table 3. Romanian scientific personalities from the field of Chemistry and their bibliometric indices.**

Code	Total number of ISI papers	Total number of citations	Average citations per paper	Average citations per year	Hirsch index
P1	285	4242	14.88	80.04	33
P2	191	3979	20.83	128.35	31
P3	167	2374	14.22	79.13	26
P4	93	1623	17.45	77.29	23
P5	187	3103	16.59	172.39	22
P6	240	1500	6.25	40.54	20
P7	226	1487	6.58	34.58	19
P8	168	722	4.30	21.24	12
P9	70	347	4.96	20.41	11
P10	133	508	3.82	9.77	10
P11	164	436	2.66	9.08	9
P12	106	387	3.65	9.00	9

A statistics on the number of papers published by a researcher per year shows values of 8.5 papers/year in Iceland, 3.5 papers/year in Finland, 3.3 papers/year in U.S.A. etc. [13, 14]. A country rank according to the number of citations per paper, valid for 1998-2008, reveals that U.S.A. holds the first position with 14.93, immediately followed by the Netherlands (14.79), Switzerland (14.37) and Sweden (12.33) while the last positions are occupied by India (5.28) and Turkey (4.77) [15].

As for the exceptional performances of some personalities like the Nobel Prize laureates, Table 4 illustrates some special examples.

**Table 4. Bibliometric parameters of some exceptional personalities [16, 17].**

Rank	Name	Country	Total number of ISI papers	Total number of citations	Average citations per paper	Hirsch index
1	C. M. LIEBER	USA	74	17776	240.21	98
2	M. O'KEEFFE	USA	73	12910	176.84	60
3	R. R. ERNST (Nobel Prize laureate)	SWITZER- LAND	182	13069	71.80	89
4	J. M. LEHN (Nobel Prize laureate)	FRANCE	307	10823	35.25	114
5	R. HOFFMANN (Nobel Prize laureate)	USA	248	8269	33.34	113

Sometimes, only a few articles are very much cited, as shown by the data presented in Table 5 [18].

**Table 5. Researchers with high-impact papers in Chemistry [18].**

Rank	Name	Country	Number of high impact papers	Citations	Citations per high impact paper	Hirsch index
1	K. C. NICOLAOU	USA	6	707	117.8	99
2	M. MANN	Germany	6	584	97.3	86
3	G. M. WHITESIDES	USA	5	493	98.6	163
4	G. R. FLEMING	USA	5	325	65.0	83

Another classification made according to the number of citations per paper reveals the inherent differences existing between the field of science (Table 6).

**Table 6. The average number of citations per paper (2000-2010) according to the scientific field [19].**

Field	Average citations per paper	Field	Average citations per paper
Biochemistry	17.25	Physics	8.97
Chemistry	11.19	Mathematics	3.48

In another paper [20] the average number of citations per paper in the field of Chemistry, valid for 2000-2004, is 8.54 for Analytical Chemistry, 7.93 for Inorganic Chemistry, 8.97 for Organic Chemistry and 9.05 for Physical Chemistry.

From the study of some authors [21] it results that the maximum number of citations per paper usually appears 2 or even 3 years after the publication of that paper.

The data in Table 3 show the existence of two main types of researchers; the former (positions 1-7) is characterized by values of the average citations per paper close to the ones in the USA and the latter (positions 8-12) is far from these values but still present in the specialist field literature. However, values like the ones in the Tables 4 and 5 are completely absent in our country.

As Fig.2 illustrates, there is a linear dependence between the researcher's Hirsch-index and the number of citations ( $\ln C$ ). A similar dependence was also indicated in the paper under [22].

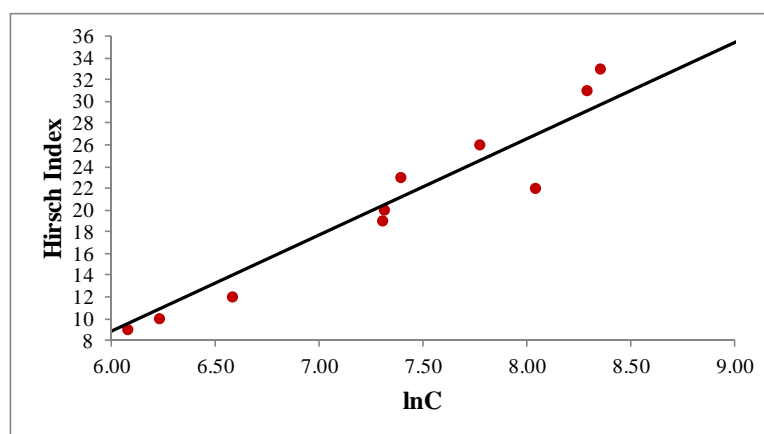
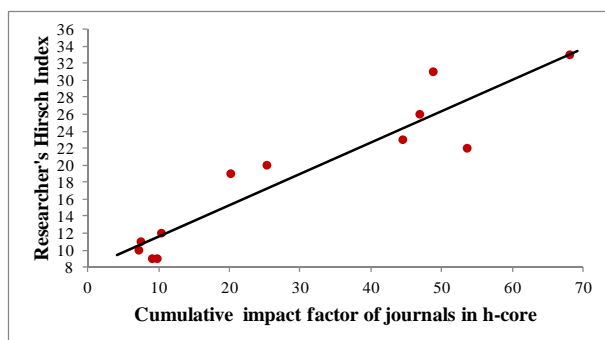
**Fig. 2. The researcher's Hirsch-index dependence on the logarithm of the total number of citations.**

Table 7 presents the impact factors, the influence scores and the Hirsch-indices, in the form of independent, cumulative values of the journals in which the papers in h-core of the personalities in Table 3 were published.

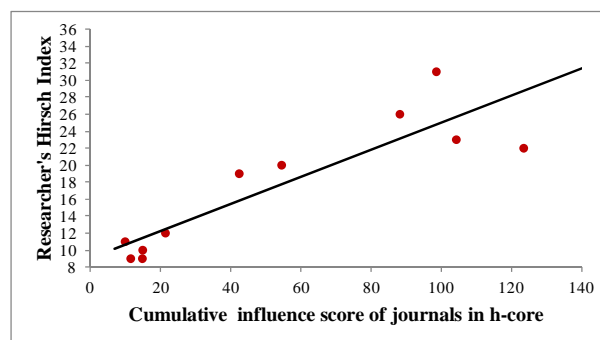
**Table 7. Cumulative impact factors, cumulative influence scores and cumulative Hirsch – indices of the academic journals in h-core in which the people in the table have published their scientific papers.**

Code	Cumulative impact factor	Cumulative influence score	Cumulative journal's Hirsch - index	Researcher's Hirsch index
P1	68.1	148.3	3672	33
P2	48.8	98.6	3285	31
P3	46.9	88.2	2664	26
P4	44.5	104.3	2257	23
P5	53.6	123.5	1294	22
P6	25.3	54.5	1167	20
P7	20.2	42.4	922	19
P8	10.4	21.4	786	12
P9	7.5	9.9	643	11
P10	7.2	14.9	886	10
P11	9.1	11.5	744	9
P12	9.8	14.8	632	9

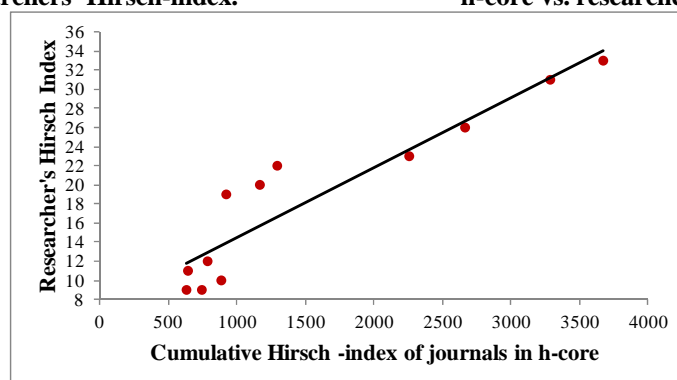
Figs. 3–5 show the linear dependencies of these values of individual Hirsch indices belonging to these people.



**Fig. 3. The cumulative impact factor of journals in h-core vs. researchers' Hirsch-index.**



**Fig. 4. The cumulative influence score of journals in h-core vs. researchers' Hirsch-index.**



**Fig. 5. The cumulative Hirsch-index of journals in h-core vs. researchers' Hirsch-index.**

These data clearly show that the researcher's Hirsch-index increases with the growth in value of the bibliometric indicators of the scientific journals in which the researchers' papers have been published. The effect of the rising direction for the three bibliometric indicators is based on a common influence of the number of citations exerted upon these indicators.

Correlation coefficients of the Hirsch-index dependency on:		
Cumulative impact factor	Cumulative influence score	Cumulative influence score
0.929	0.956	0.967

The scientific performances of the Chemistry professors presented in this paper allow us to conclude that, under the current conditions of development in the Romanian society, the results can be considered honorable. It is the ISI papers that provide visibility, impact and prestige at international level to the people involved in higher education at research. At present, the European Standard is of 1 paper per year per researcher [23].

We should equally point out the necessity of putting the research results into practice. Professor Andrei Marga said: "Primary importance is given to the publication of papers (this is indispensable), but their technological impact is neglected. That is why, in Romania, we have for example ISI Chemistry papers, but, in the meantime, the country's chemical industry has disappeared" [24].

Orison Sweet Marden, an American physician and writer (1850 – 1924) stated that "life can be equally wasted if you are trying to do too many things at one time or simply doing nothing and letting events overcome you". The Romanian Academy provides numerous examples of outstanding researchers in full swing and the names of many Romanian scientists rank first among those of great men of science throughout history.

#### 4. CONCLUSIONS

The average values of bibliometric/scientometric parameters (i.e. the total number of ISI quoted papers, the average citations per paper, the average citations per year, the Hirsch-index) for the professors in the Chemistry Faculties of the Romanian universities lead to the following decreasing trend of performances:

*University of Bucharest > "Babes-Bolyai" University of Cluj-Napoca > "Alexandru Ioan Cuza" University of Iasi.*

At the same time, this direction is in accordance with the classification (A) of Romanian Universities programmes ranking.

The average values of the same bibliometric/scientometric parameters for the professors in the Chemistry Faculties of other universities correspond to the classification (B) and (C) of Romanian Universities programmes ranking in:

*West University of Timisoara > "Valahia" University of Targoviste > University of Craiova.*

The researcher's Hirsch-index varies linearly with the logarithm of the total number of citations.

The researcher's Hirsch-index varies linearly with the size of the bibliometric / scientometric indicators of the scientific journals in "h-core" in which the researchers' papers are published (the journal's cumulative impact factor, cumulative influence score, cumulative journal's Hirsch-index). This demonstrates that the more valuable the bibliometric / scientometric parameters of the academic journals for publication, the higher the researcher's Hirsch-index becomes.

The scientific performances of the academic Chemistry professors, members of the Romanian Academy or Correspondent members constitute examples of great visibility and international prestige.

The ranking of the Faculty of Sciences and Arts of Valahia University of Targoviste in a position close to the one of Chemistry Faculties of important Romanian universities is an honour and obliges to further efforts in order to preserve this performance.

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