

## BRAZILIAN PRODUCTION IN BIOCHEMISTRY INTERNATIONAL VERSUS DOMESTIC PUBLICATION

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### ABSTRACT

This work describes a bibliometric survey on scientific production in biochemistry originated from 19 Brazilian institutions, which comprised 487 staff investigators, 70-80% of active investigators biochemists. These investigators published about 3000 papers in international journals in the period 1970-1985, which generated about 17000 citations from 1983 to 1987, according to the Institute for Scientific Information data base. In this survey we distinguished what we called endogenous articles (produced in Brazil) from exogenous articles (produced abroad by Brazilian biochemists), in terms of the spectrum of journals in which they were published and the number of citations generated per article. A comparison was also performed for the two groups in terms of the impact factor generated by Brazilian articles in a given journal versus the expected impact factor for all articles published in that journal. In all cases we detected a certain disadvantage for endogenous articles, the possible reason of which is discussed. Biochemistry is one of the scientific areas in Brazil in which the investigators make a large effort to publish in international journals. We observed differences in the impact generated by these international papers, when biochemistry was compared with other areas which exhibit the same tendency towards an international output. From these observations we discuss the pertinence of publishing for an international audience as opposed to publishing in domestic journals.

### RESUME

*Cet article décrit une étude bibliométrique sur la production en biochimie issues de 19 institutions au Brésil, regroupant 487 chercheurs, soit environ 70-80% de la population totale de chercheurs en biochimie du pays. Ces chercheurs ont publié environ 3.000 articles qui ont généré 17.000 références de 1983 à 1987, selon la base de donnée de l'Institute of Scientific Information. Cette enquête distingue les articles endogènes (publiés localement) et articles exogènes (publiés à l'étranger) en fonction de l'éventail des revues de publication et du nombre de citations reçues. Une comparaison est effectuée entre les deux groupes sur le facteur d'impact généré par des articles brésiliens dans une revue donnée par rapport à l'ensemble des articles publiés par cette même revue. Dans tous les cas on note un désavantage pour les articles endogènes dont les causes possible sont présentées ici. La biochimie est un domaine au Brésil où les chercheurs font le plus d'effort pour publier dans des revues internationales. Nous comparons l'impact des articles internationaux avec ceux d'autres domaines qui font le*

*même effort de publication internationale. A partir de ces observations nous discutons la pertinence de la publication locale par opposition à la publication internationale.*

## INTRODUCTION

In Brazil different scientific fields present rather distinct trends in terms of the audiences to which the publications are aimed. If we consider the database generated by CAPES (a federal agency that deals with graduate studies) we see that in 1982 Brazilian scientists published 7,968 journal articles, 5,995 in national journals (1). Therefore only one quarter of Brazilian science is aimed at an international audience, while three quarters is published in national journals, presumably for national consumption only (1). Although this database refers only to graduate programmes, in practice it covers most of the Brazilian scientific publications, 85% according to Castro (2). If any attempt is made to interpret these results it should be considered that the ratio between international and total publications varies substantially from one area to another. Thus, in social sciences this ratio in 1982 was 7.2 %, in agricultural sciences it was 14.3% and in basic areas (biology, chemistry, physics, geology, astronomy and mathematics) international publication reached 46.9% (1). Each sub-area exhibits its own profile: in biology the ratio was 40.7 % and in physical, chemical and earth science international publications comprised 53.2%. In the period 1983-1986, 73 % of the 1,012 Brazilian articles in chemistry were published in international journals, and 92% of the latter were included in the ISI database (3).

Why these different areas present different patterns of publications is a matter of study and debate. Certainly, history and strategy are part of the explanation. However a more comprehensive analysis is required in order to have a better understanding of this phenomenon. An effort in this direction seems to be necessary because the results may have implications in science policy.

## BIOCHEMISTRY IN BRAZIL

Biochemistry in Brazil is a relatively developed scientific area. Although it is difficult to delimit its boundaries we know that there are at least 700 active professional investigators registered at the Brazilian Biochemical Society, corresponding to 3 to 4 percent of the total number of scientists in Brazil. Most of them were trained in North American or European Institutions, either as graduate students or as post-doctoral fellows, supported by Brazilian governmental programmes. They brought with them the spirit of competitiveness and the awareness of the international character of biochemistry as a basic area of sciences. Because of that a desire to report the scientific findings in the best international journals is common in most of the biochemistry departments, there is a pressure by grant and promotion committees for good scores of international publications. Given the relatively fragile infrastructure of sciences in Brazil this trend poses a strain over the members of this community which is not common in many other Brazilian scientific areas where publishing is a much less painful task. In fact, virtually all of the about 400 Brazilian scientific journals have either

lenient or no editorial policy at all. From these considerations several questions may be raised: (i) to what extent the effort of Brazilian investigators to address an international audience is rewarded? (ii) does this endeavor pay off in terms of progress of a specific scientific area as compared to areas in which the tendency is publishing in domestic journals. To start addressing these questions an assessment of the pattern of publication and international repercussion of the articles of each area is required. In the present work we describe a survey of publications of Brazilian biochemists in the period 1970-1985 and the impact they produced in terms of citations scanned by *Science Citation Index* (SCI)

## SURVEY

We chose to cover 19 departments and/or institutions involved in biochemistry/molecular biology investigation, which are known to represent the best in this area in Brazil. These institutions comprised 487 staff members in 1985, which represented about 70 % of the professional Brazilian biochemists but that in terms of production represented about 90 % of the publications in this area. Eight of these 19 institutions are located in the state of Sao Paulo and 5 in the state of Rio de Janeiro, the remaining being spread over 6 other states. From the publication lists of these 487 investigators we compiled a total of 3301 papers published between 1970 and 1985.

Table 1. Publications in biochemistry in the period 1970-1985

1-Total of publications	3,301
2-International publications*	2,997
3-Publications in Portuguese	304
4-Endogenous international publications **	2,218
5-Exogenous international publications **	779

\* Written in a foreign language. Over 95% of these publications were in English. \*\* See text .

Table 1 shows that 92 % of these papers were addressed to an international audience, the vast majority written in English. However many of these international papers were not in fact generated in Brazil since most of the Brazilian biochemists spent a doctoral or postdoctoral tenure abroad. Therefore each of these 487 investigators were requested to identify those papers which reported work entirely performed in a foreign institution. These we called **exogenous** publications as opposed to the **endogenous** ones, which were entirely or partially (in collaboration) developed in a Brazilian institution. Twenty-six percent (779) of these international publications were exogenous. Therefore the remaining 2,218 were endogenous international papers, which still represents 87.9 % of the total genuine Brazilian publications (compare lines 3 and 4 of Table 1). The international publications in biochemistry correspond to a much higher percentage than the average 46.9 % of international publications in

basic sciences in Brazil (I) and probably meets no parallel in other sub-areas of Brazilian science.

Presently, the best way of detecting the repercussion of international publications is through the rate of citations they earn through the SCI survey. Table 2 shows the citation rates surveyed in a 5 year period (1983-1987) of the papers published in the period 1970-1985. The first point that comes to our notice is that exogenous papers had an impact 2.8 fold higher than the endogenous papers. That is, Brazilian biochemists, operating in American and European laboratories achieved with their publications a significantly better score of citations than when operating in Brazil. Among the explanations that can be considered, one is the possibility that the profile of journals utilized for exogenous publications had been distinct from those utilized for endogenous publications.

Table 2. Citation rates in the 1983-1987 period related to the international publications of the period 1970-1985.

Type of international publication	Number of publications	Number of citations	Citations / publications
Endogenous	2,218	8,687	3.92
Exogenous	779	8,724	11.20
Total	2,997	17,411	5.81

This is in fact the case: The 2997 international papers were published in 698 different journals (Table 3). The great majority (426) were international journals, 33 were Brazilian journals and only 9.6 % of these papers were published in proceedings of congresses (monographs).

Table 3. Distribution of International publications

	No. of journals	No. of publications	No. of citations	Citations / publications
International journals	429	2,280	16,458	7.22
Brazilian journals	33	428	353	0.82
Monographs	228	289	600	2.08
Total	698	2997	17,411	5.81

The patterns of the journals mostly utilized for endogenous and exogenous publications were rather distinct, as can be seen in Tables 4 and 5. Among the journals that most published endogenous papers five were Brazilian journals. The impact factors of the journals appearing in Table 4 were on average significantly lower than those for the journals mostly utilized for exogenous publications, appearing in Table 5. The conclusion can be drawn that when operating abroad Brazilian scientists found it less arduous to have their papers accepted by the

Table 4. Journals that most published endogenous papers

Journals	Publications	Citations	Citations/ Publications	Impact Factor
Acad Bras Cienc *	96	73	0.76	0.115
Biochim. Biophys Acta	87	668	7.91	2.739
Comp Biochem Phys	86	237	2.76	0.784
Braz J Med Biol Res *	75	102	1.36	0.447
Arq Biol Tecnol *	73	18	0.25	0.082
Biochem Biophys Res Co	53	304	5.74	3.785
J Biol Chem	42	615	14.64	6.315
Photochem Photobiol	42	307	7.31	2.413
IRCS-Bioch	39	27	0.69	---
J Protozool	36	229	6.36	1.209
Arch Biochem Biophys	34	188	5.53	2.238
Biochemistry	32	382	11.94	3.829
J Parasitol	32	157	4.91	0.783
Exp Parasitol	29	226	7.79	1.363
Experientia	28	39	1.39	1.003
Carbohyd Res	21	71	3.38	1.462
CR Acad Sci III-vie	21	9	0.43	0.302
Rev Microbiol *	20	9	0.45	0.022
Febs Lett	19	107	5.63	3.315
Cien Cult *	19	9	0.47	---
Biochem Pharmacol	18	65	3.61	2.401
Biochem J	17	69	4.06	4.234
Insect Biochem	17	131	7.71	1.797
Brain Res	16	95	5.94	2.859
J Insect Physiol	16	147	9.19	1.597
J Submicrosc Cytol	16	27	1.69	0.636
Acta Trop	16	80	5.00	1.092
Infect Immun	15	108	7.20	3.023
Res Commun Chem Path	15	10	0.67	0.865

\* Refers to Brazilian journals; Impact factors correspond to 1986.

most prestigious journals as compared to when operating domestically. This can be accounted for by the prestige of the laboratory where the work was developed and/or by the fact that this work was on average of a better quality than that evolved in his/her home institution. The knowledge of the real explanation for the trend aforementioned is of great importance in the area of scientific policy but no data are available to draw a definite conclusion.

Table 5. Journals that most published exogenous papers

Journals	Publications	Citations	Citations/ Publications	Impact Factor
Exp Neurol	34	259	7.62	1.224
P Natl Acad Sci USA	31	622	20.06	9.165
Mol Pharmacol	30	429	14.30	2.183
J Biol Chem	25	734	29.36	6.315
J Pharmacol Exp Ther	23	197	8.57	3.547
Biochem Biophys Acta	17	137	8.06	2.739
Febs Lett	17	75	4.41	3.315
Psychopharmacology	14	41	2.93	2.428
J Immunol	13	187	14.38	6.190
J Appl Physiol	13	148	11.38	2.519
Eur J Biochem	12	134	11.17	3.655
J Neurochem	11	36	3.27	3.580
Arch Biochem Biophys	11	82	7.45	2.238
Biochemistry	11	171	15.55	3.829
Carbohydr Res	11	58	5.27	1.462
Biochem Biophys Res Commun	10	97	9.70	3.785
J Am Chem Soc	10	144	14.40	4.435
J Mol Biol	10	53	5.30	6.597

Impact factors correspond to 1986.

Table 6. Impact factors of Brazilian articles as compared to overall impact factors of SCI indexed

Journals	Endogenous	Exogenous
Brazilian articles in 1984 and 1985	353	107
Total citations in 1986	451	353
Number of journals utilized	124	59
Average impact factor*	1.278	3.300
Expected impact factor**	1.911	3.716
Number of journals in which the impact factor of Brazilian articles was higher than the overall impact factor	26 (21%)	20 (34%)

\* Citations in 1986 of the articles published in 1984 and 1985.

\*\* Weight average impact factor of the journals, considering the number of Brazilian articles that each one published in 1984 and 1985.

However, the problem can be more directly addressed by asking the question: once a Brazilian scientist succeeds in publishing a paper in a given international journal does this paper earn, on average, a citation rate comparable to that of the

journal? To answer this question we took as reference for citation survey the year of 1986 and considered the publications of 1984 and 1985. A total of 460 papers were published in ISI indexed journals in -these two years, divided into 353 endogenous papers and 107 exogenous papers (Table 6). The average impact factors were 1.278 and 3.300, for the endogenous and exogenous papers, respectively. This again reflects the trend of publishing the exogenous papers in more prestigious journals. If we now compare these impact factors with those expected if the Brazilian articles had the same citation rates that the overall articles in each of these journals the results are 1.278 versus 1.911 for endogenous papers and 3.300 versus 3.716 for exogenous papers. The difference between the two figures in the latter case is not significant ( $p > 0.1$ ) which would mean that Brazilian biochemists working abroad, and counting on the prestige of the institution and better material facilities, are doing as well as central world biochemists. Back home they keep making a great effort to publish in international journals but have on average to content themselves with less prestigious journals. Moreover, when the endogenous papers are published in international journals their impact (1.278) is lower than the expected from the journals where they were published (1.911) and in this case the difference is significant ( $p < 0.05$ ). If we raise the reasonable hypothesis that the editors of these journals are not lenient and on average accept papers of comparable quality, independently of the geographic origin, then some bias might be occurring in the process of citing science which disfavors less renowned groups from Third World countries. However it should be pointed out that this difference is not exaggerated: on average Brazilian biochemists achieved a citation rate corresponding to 67 % of that achieved by their colleagues from central countries, a figure which is just slightly higher than 0.64, the average ratio of direct citation counts to expected citation rates for all Brazilian papers (4). This figure is not significantly affected by self-citation or "in-house" citation which in the present study corresponded to 18 % , a value which falls in the range found for other specialties (5,6).

## DOMESTIC VERSUS INTERNATIONAL PUBLICATION

In a recent survey it was found that a Brazilian chemistry paper in the first three years after publication earns less than one citation in the international literature (3). In this same survey it has been detected that 73 % of the Brazilian chemistry papers were published in international journals, a figure that depicts the effort of the scientists in this area to present their findings to an international audience. Because the outcome of this endeavor was considered to be rather poor, the question was raised by the author as to whether a better policy wouldn't be to strengthen Brazilian journals, making them meet international standards and consequently become more visible abroad. This is a fundamental question in the area of scientific policy and deserves to be addressed from multiple angles.

One idea that permeates this debate is that regardless of the good quality of a scientific work developed in a Third World country, the international recognition it will earn is inevitably poor because First World scientists virtually ignore the work published by Third World scientists. However, this idea does not resist to a

more careful analysis . The fact is that large differences can be found in terms of international impact among different areas of Brazilian science and in, a given area, among different investigators. It is certainly not expected that the areas tending to publish in domestic journals achieve any significant citation rate. Among the areas in which a clear effort is identified towards all international output, the results may vary significantly. For instance, the 272 international papers in biochemistry published in 1982 by Brazilian scientists earned 8.8 citations per paper over the period 1983-1987, or 1.76 citation per year per paper. If we consider only the endogenous papers of 1982, the publications were 207 and the citation rate was 1.00 citation per year per paper, or 0.82 if we discount the self-citations. This is a much more expressive figure than the 0.30 value for the average Brazilian chemistry paper (3), another area in which a major effort is conducted towards an international output.

In addition, it should be mentioned that these figures are rather distinct among different institutions (7). In the case of the department of Biochemistry of the University of Rio de Janeiro, for instance, each international publication of 1982 earned 1.6 "real" citations per year, in the period 1983-1987. Finally, 85 endogenous papers (3.9 % of the total ) earned 20 or more citations in the period 1982-1985. These most cited papers earned 32 % of all citations for endogenous papers and were published by only 28 senior authors (5.6 % of the total). This denotes a concentration effect whereby a relatively small number of Brazilian biochemists is responsible for most of the impact generated by Brazilian biochemistry papers.

If we try to delineate the general characteristics of these investigators we see that they are all recognized scientific leaders in Brazilian biochemistry, have published a large number of papers, have been responsible for the training of many young scientist and have kept close contact with First World colleagues, participating in meetings as invited speakers, visiting laboratories, etc. In other words, they constitute a group of scientists who have somehow overwhelmed the intrinsic difficulties of doing science in Brazil and would be classified by international standards as important contributors in their areas.

These investigators learned very soon the challenge of publishing in the best international journals. They recognize that to a certain extent Third World scientists have to overcome extra barriers in relation to their First World colleagues when trying to publish or earn credit for their published work. There is in fact some bias and even prejudice in the process. However this is inevitable and tends to diminish as a national community grows stronger and acquires prestige in the performance of science. Meanwhile coordinated action of third world science communities might help to enhance awareness of first world scientists for some inequities.

The alternative to a major effort to publish domestically seems to be fruitless. Brazilian scientists are now publishing about 2000 papers yearly in international journals. To accommodate half these articles in Brazilian journals would require roughly 20 new Brazilian journals. It is not just a matter of adding 20 more to the 400 Brazilian scientific journals already marketed. With perhaps a couple exceptions these latter journals are far from meeting the international standards. To produce really high quality journals, an enormous effort would be required involving a large amount of investment and organization that Brazil is certainly

incapable to face. If a policy decision were taken toward this aim the best we could expect is to set up a scientific press organization, commercially oriented (as is the case for the scientific press houses abroad) and keeping no symmetry to the Brazilian science output. It would be run by international editorial boards, publish mainly international articles, bring funds to Brazil and, in terms of scientific benefit, could attenuate to a certain degree the alleged bias towards Brazilian papers that were submitted. This seems to be the situation in the Netherlands, which has a centennial tradition in scientific publication. It does not seem to pay off the effort required for such an enterprise.

If science is to be consumed internationally there seems to be no way other than trying to improve our conditions to compete for the best journals and to struggle to earn credit for the relevant findings of Brazilian science. This means becoming organized in order to lobby influential editors to enforce fairness in the processes of judgment and crediting. It remains that we have to improve our science since this will bring as consequences the rise of fine scientific journals and international recognition.

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