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Analysis of technological production in biotechnology in northeast Brazil

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ABSTRACT

The aim of the article was to analyze the technological production in Biotechnology in the northeast of Brazil between 1983 and 2012. Data were collected from the analysis of patent applications submitted by professors affiliated to graduate programs in Biotechnology in the region. The research sources were as follows: institutional websites of the northeastern graduate programs, patent bank of the National Institute of Industrial Property (INPI) and the Lattes platform maintained by the National Research Council (CNPq). A total of 191 patent applications submitted by researchers residing in the region were identified. Data were analyzed using bibliometrics. The results point to a growing trend in the technological production of biotechnology in the region, with universities and research institutes accounting for the largest number of applications. There was also intense cooperation with public universities in the southern and southeast regions.

1. Introduction

The actions of Science, Technology and Innovation (ST&I) implemented by the Brazilian government over the last decade has promoted investments in the area of biotechnology. In agreement with the Science, Technology and Innovation Plan (PADCTI) [1], which considers Biotechnology as a strategic area, the ST&I actions have enabled the training of human resources, construction and approval of a legal framework aimed at establishing cooperation between universities and companies. In addition, the implementation of the Sectorial Biotechnology Fund and an endeavor to decentralize the infrastructure of biotechnology support must be pointed out, as investments had been only focused on developing the Brazilian southeast and southern regions.

As a result of these actions, the overall growth rate of Brazilian scientific production in 2011 surpassed the international average, ranking 13th position [2] in 2011, while in 2002 it ranked 17th in scientific production. The highest rates of articles are in the fields related to biotechnology, particularly applied chemistry and chemical engineering [3].

In terms of technological production, the Brazilian growth pattern was significant, albeit on a smaller scale. The number of filings of patent applications in the United States Patent and Trademark Office (USPTO) from 1990-2000 increased 150% in Brazil [4]. Although the Brazilian participation in the International Patent System is limited, it has been growing rapidly. Among the BRICS[1] countries, Brazil currently ranks 4th in terms of patent applications in at least one or two countries, and it ranks 56th in the international scenario [5].

As for the Brazilian scenario for patent applications in biotechnology, studies [6] report a linear growth over the last decade, particularly for the biennium 2007-2008, as there was an increase of 30% compared to previous years. When analyzing patent

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[1] In economy, BRICS is an acronym that refers to the founding member countries (the BRICS group: Brazil, Russia, India, China, South Africa), which together form a political cooperation group.

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applications in the subclass C12n retrieved from INPI (National Institute of Industrial Property) between 2001 and 2008, Brazil ranked fifth among the ten countries with patent applications [7].

In an analysis of patent applications, INPI states that 194 patents were filed in Brazil from 2001 to 2005, which corresponds to 8.3% of all patent applications [8]. Of the patent applications in Brazil, 73.5% of them were from institutions located in the southeast and southern regions. It should be emphasized that in order to mitigate the differences in indicators in the ST&I field, the Brazilian government has been promoting decentralization actions of the ST&I infrastructure. Thus, considerable efforts have been made to strengthen the Brazilian regions, particularly the mid-western, northern and northeast regions, to increase cooperation with the federal system by strengthening and decentralizing the national system of research and development. Within this perspective, specific actions have been carried out in the mid-western, northern and northeast regions, among them the allocation of 30% of the resources of the science and technology sector funds and the increase of graduate programs in biotechnology aiming to train human resources.

Among these regions, the Northeast Regional Development Plan (PRDNE) in the northeast is one of the pillars to improve ST&I indicators and "promote competitiveness of the productive sector" [9], which has been led to an increase in scientific and technological productions in the field of biotechnology [10].

In view of the regional context, as biotechnology is a strategic area to improve ST&I indicators and has changed the Northeast region, the present research proposes to map the technological production in biotechnology in the Brazilian Northeast to indicate elements for a governmental decision making that favors the dissemination of biotechnology in technological areas.

From these general objectives, the specific objectives of the study were: (a) to present an overview of the activity of patenting in biotechnology in the Brazilian Northeast; and (b) to analyze the technological cooperation among institutions regarding this activity, with emphasis on the scientific characteristics of the inventors.

Among the indicators to measure innovation and/or understand the production of knowledge, experts of innovation have been adopted the study of patents as one of these indicators [11,12]. One of the methods that can help to classify, map, and systematize scientific and technological production is bibliometrics [13]. According to the authors, this method has become an increasingly significant indicator of scientific and technological production in certain fields and it is a valuable strategy for the generation, systematization, and dissemination of knowledge.

It is also worth noting that bibliometric techniques are extended to the study of knowledge in technological production, since articles and patents, from a documentary point of view [14], have similar characteristics (author/inventor, institution/applicant, bibliometric/official classifications, etc).

2. Theoretical background

2.1. Patents as an innovation indicator

Among the innovation indicators, patents can be used to identify and evaluate innovations at different levels [11,15–22]. Thus, analyzing patents to measure the process of transformation and application of knowledge and map the evolution of new fields of science and technology according to the number of patents indicates the level of technological activity and the outcome of the inventive process [23].

In contrast to the above and at the same time complementing the discussions, it has been argued that patents can be used to identify and evaluate national, sectorial and regional innovations; however, patents are only a partial indicator of innovation [24]. Among the innovation indicators based on patents, the authors cite the number of patents as a way to verify the willingness of a company, sector or country to apply for patents. Nevertheless, as patenting occurs during the process of research development as a means of protecting knowledge, this may not provide the adequate measurement of the economic or commercial potential of innovation. In this aspect, it is important to note that not every patent granted becomes a commercial product.

Another point to consider, when using the patent indicator, is the structure of the national innovation system. The number of patents is unattractive in countries with a poor national innovation system. While searching for an alternative to measure the degree of innovation, these countries have adopted the number of patent applications as an alternative to check which institutions, sectors, and regions are developing innovation. In this perspective, the number of patent applications enables the analysis of safety activities for the production of knowledge, with the main objective to guide ST&I policies of a country, sector or region.

Thus, this paper aims to contribute to the understanding of safety activities for the production of knowledge generated by researchers, laboratories, and companies, particularly in the field of biotechnology, in a country with a poor national innovation system [25].

2.2. Patents in biotechnology

Due to the interdisciplinary nature of biotechnology and its commercial potential [26,27], the term *biotechnology* has different definitions, which depend on each author or situation, as well as the time and place analyzed. Because of this dynamics, it is appropriate to discuss the concept of biotechnology adopted by the Brazilian government and the definition of patents in biotechnology, considering the statistical summary of patents.

According to the Convention on Biological Diversity – CBD – the Brazilian government understands the concept of biotechnology as "any technological application that uses biological systems, living organisms, or derivatives to make or modify products or processes for specific use" [28]. This concept has also been adopted by the Biotechnology Development Policy - BDP [29].

On the other hand, the OECD (Organization for Economic Cooperation and Development) understands the term biotechnology as being the "application of science and technology to living organisms as well as parts, products and models to alter living organisms or not, with the purpose of producing knowledge, goods or services" [30]. The techniques of modern biotechnology include the following: DNA (deoxyribonucleic acid); RNA (ribonucleic acid); proteins and other molecules; cell cultivation and tissue engineering; biotechnology processes; subcellular organisms; bioinformatics and nanobiotechnology.

In general, it is understood that the BDP definition includes the techniques of traditional, intermediate and modern biotechnology, of which Brazil makes no distinction; the OECD, on the other hand, only includes modern biotechnological techniques, as noted in the above definition. Thus, the Brazilian definition of biotechnology does not follow the strict framework codes of the International Patent Classification (IPC).

These discussions directly impact the analysis of patents in biotechnology because the concept defined by the OECD only lists 30 IPC codes corresponding to biotechnology patents to generate biotechnological statistics.

Among the studies that deal with the analysis of biotechnology patent applications in the Brazilian scenario, it has been observed that the concept of biotechnology sometimes follows the BDP guidelines [31–34] and other times the OECD definition [6,8,35,36].