

Commentary

Different Rhythms of Health Biotechnology Development in Brazil and Cuba

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Abstract: Biotechnology is typically associated with the centres of learning and firms in industrialised countries but usually not with institutions in developing countries. Developing nations are however, becoming active in this field and are increasingly using recombinant methods to produce new and innovative health products for their populations. Here we will examine health biotechnology development in two developing countries, Brazil and Cuba. We will compare the major characteristics of their health biotechnology sectors and highlight factors that have shaped their development in order to understand better what main factors and conditions can promote health biotechnology innovation in developing countries.

Introduction

Even though the biotechnology sector is dominated by some of the richest countries in the world, developing countries are increasingly making their mark on the field. Biotechnology can be used to address various health problems of people in developing countries and contribute towards better global health [1-3]. Furthermore, developing countries themselves have been shown to be active in this field; they are engaged in health biotechnology research and are increasingly using recombinant methods to develop new and innovative products for their populations [4]. There is increasing recognition that instead of importing solutions for their health problems, developing countries can innovate and find solutions locally [5]. Our previous research on health biotechnology innovation has supported this observation [6]. We examined health biotechnology development in seven developing countries that have demonstrated successes in this field. Amongst them were Brazil and Cuba [7,8]. Here we will compare the development in these two countries and discuss the major factors that have shaped the characteristics of their health biotechnology sectors. We chose Brazil and Cuba as they are amongst the most advanced countries in the Latin American and the Caribbean region in terms of health biotechnology. They share important characteristics that can influence activities in this field but have at the same time followed quite different routes in their developments.

What Brazil and Cuba share

Both Brazil and Cuba are developing countries that fit the World Bank's lower middle income category [9]. The GDP/Capita is US\$7770 for Brazil (ranked 63 of 177 countries) and US\$5259 for Cuba (ranked 91 of 177 countries) and their ranks in the human development index are 52nd for Cuba and 72nd for Brazil [10]. On the other hand Cuba and Brazil share the characteristic that they have a relatively high educational level. Figure 1 demonstrates that both Cuba and Brazil have populations with relatively high education levels with education indices well beyond the averages

for developing countries. Life expectancies are also relatively high in both countries, especially in Cuba where it has reached developed countries' levels.

In addition, Brazil and Cuba share the characteristic that their governments emphasised health biotechnology development relatively early on as biotechnology was taking off in the 1970s and 1980s. In Brazil two programmes that featured biotechnology development were launched in the 1970s by Brazil's National Research Council (CNPq), the Integrated Programme on Genetics (PID) and the Integrated Programme on Tropical Diseases (PIDE). In 1981, the government set up the National Biotechnology Programme (PRONAB) to integrate activities in the different types of biotechnology. Since then further programmes have been set up to promote biotechnology development and despite frequent turnover, the governments have continued to support biotechnology [7,11].

The Cuban government also singled out biotechnology as a promising field in the early 1980s and gave strategic importance to its development [8,12]. They promoted education in the field and set up various institutions to engage in biotechnology. They also created an interdisciplinary forum for biotechnology development the so called Biological Front, in 1981 which had the task to explore the potentials of biological sciences for Cuba. The support of the Cuban government for biotechnology development did not waiver during the hardship of the so called 'Special Period', in the early 1990s after the disintegration of the Soviet Union and Cuba's major Eastern European markets.

An additional characteristic that Cuba and Brazil share that can influence health biotechnology development is that they are members of the World Trade Organisation (WTO). Both countries have been members of the WTO since 1995 and are signatories of the Trade-Related Aspects of Intellectual Property (TRIPS) agreement. They started to implement TRIPS in 2005, which will make it difficult for them to export products without licensing if those are already patented by others. Both countries have

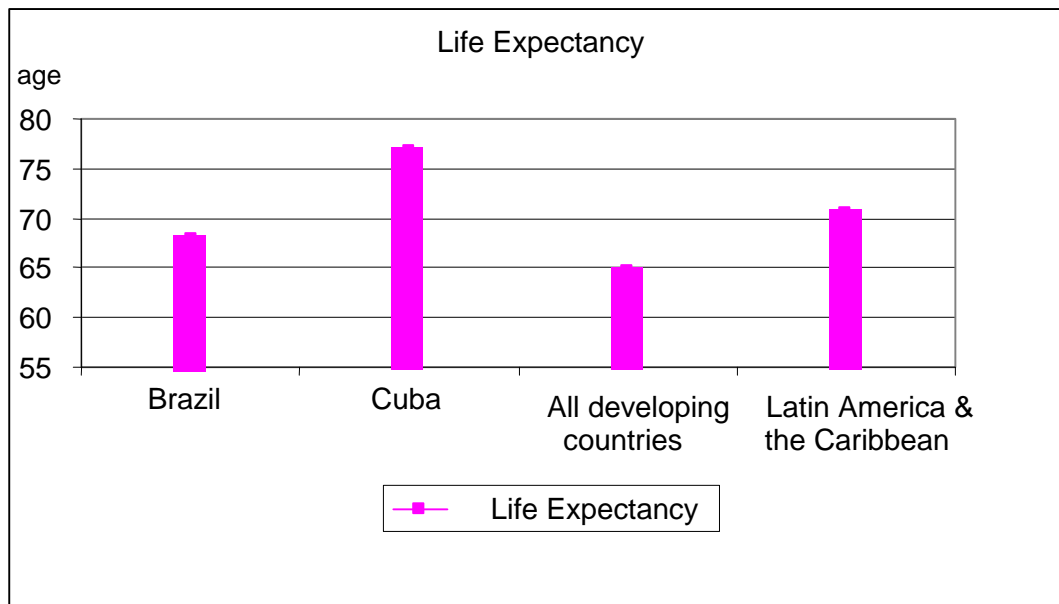
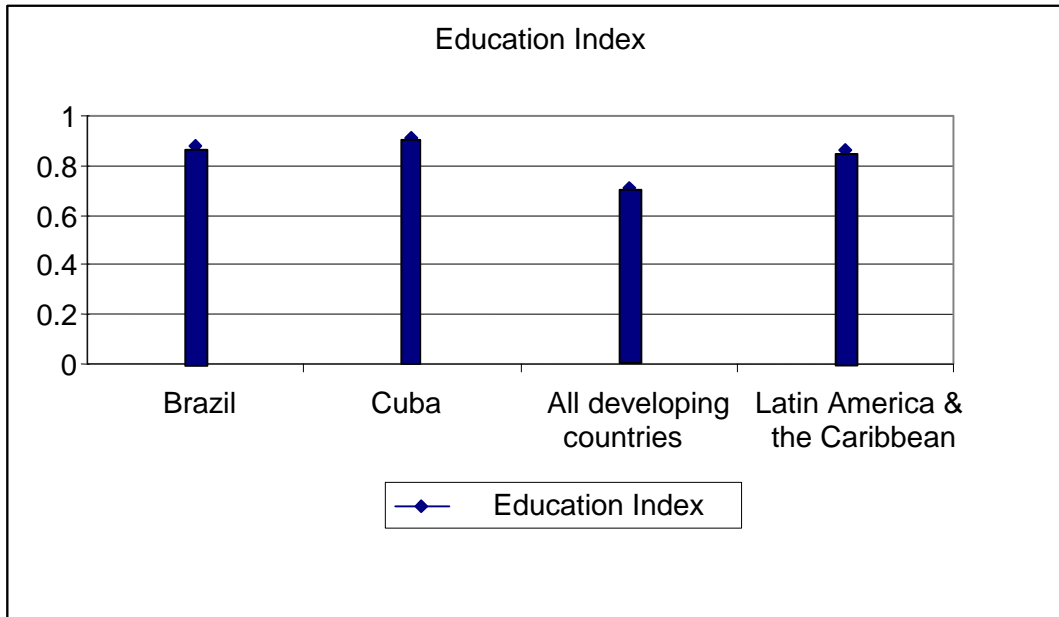


Figure 1: Education and Life Expectancies in Brazil and Cuba Compared to Other Developing Countries (Source: UNDP, Human Development Report 2004)

been driven to revise their intellectual property systems and set up more stringent patent regulations than they previously had. Their health biotechnology sectors therefore are gearing up to become innovative in order to sustain and surpass their current activity levels.

How Brazil and Cuba differ

With regards to the health biotechnology sector the major difference between Brazil and Cuba are the types of activities they emphasise. In Brazil the focus has been stronger on more fundamental research and publishing in high impact journals whereas in Cuba the emphasis has been more on developing new and innovative health biotechnology products. This does not mean that Cuba does not have its share of scientific publications or that Brazil has not developed an innovative health biotechnology product but rather the bulk of activities seem to be focused on these different types of activities, respectively. In Figure 2 we show the number of papers published in health biotechnology in the international peer reviewed literature by authors in the two countries over the period from 1991 to 2002. As can be seen the level of publishing is substantially higher in Brazil than in Cuba. This can partly be explained by a much larger population size and much larger scientific community in Brazil than in Cuba. The citation rate of Brazilian papers is also higher than Cuban papers, or 0.63 average relative citation level (1991-2002) for Brazil versus 0.45 for Cuba [13]. Brazil also has significant strengths in agricultural biotechnology. For example, it was the first country to sequence the genome of a plant pathogen, *Xyllella fastidiosa*, which is a bacterium that attacks citrus fruits [21].

When comparing the product portfolios in health biotechnology of Cuba and Brazil, the latter displays a more modest success. A recombinant human insulin product developed in the 1990s by the Federal University of Minas Gerais and the Brazilian biopharmaceutical firm Biobrás was identified by Brazilian experts to be one of the best examples of Brazilian innovation in this field [7]. Brazil also has a strong diagnostic sector and has for example developed a recombinant antigen test for Chagas disease [14]. In general Brazil has

had difficulties capitalising on its strong publication record in biotechnology, as the Minister of Science and Technology, Eduardo Campos stated 'Brazilians get lost between basic research and its transformation into technology, between academic life and the manufacturing system [15].

Cuban health biotechnology has, however, a very applied focus with an impressive product portfolio. One of the early examples of Cuban innovation in this field is the world's first meningitis B vaccine developed in the late 1980s. Cuban innovation has continued and includes, for example, humanized anti epidermal growth factor receptors monoclonal antibodies against head and neck tumours as well as the world's first human vaccine with a synthetic antigen against pneumonia and meningitis introduced in 2004 [16,17]. James Larrick, a biotechnology expert and entrepreneur in Palo Alto, California says for example, the following about Cuban biotechnology: "Their pipeline is very, very deep now It's gone into an adolescence and it's looking pretty good" [18].

Cubans have been active in licensing and setting up strategic alliances and joint ventures based on Cuban biotechnology with companies around the world. They have, for example, made an agreement with GlaxoSmithKline to produce and distribute the meningitis B vaccine in Europe and North America; a joint venture with the Canadian firm YMBiosciences to develop and market cancer therapeutics; an agreement with the US firm CancerVax to undertake joint development and licensing of Cuban cancer vaccines; a strategic alliance with the Indian firm Panacea Biotec to manufacture hepatitis B vaccine in India; and joint ventures with the Chinese firms Beijing Jingyitaixiang Technology Development, Shanxi Xinyutong Material Commerce and China International Science Centre for cancer research. Despite a relatively small population size and limited economic resources Cuba has been able to build up an enviable track record in biotechnology products.

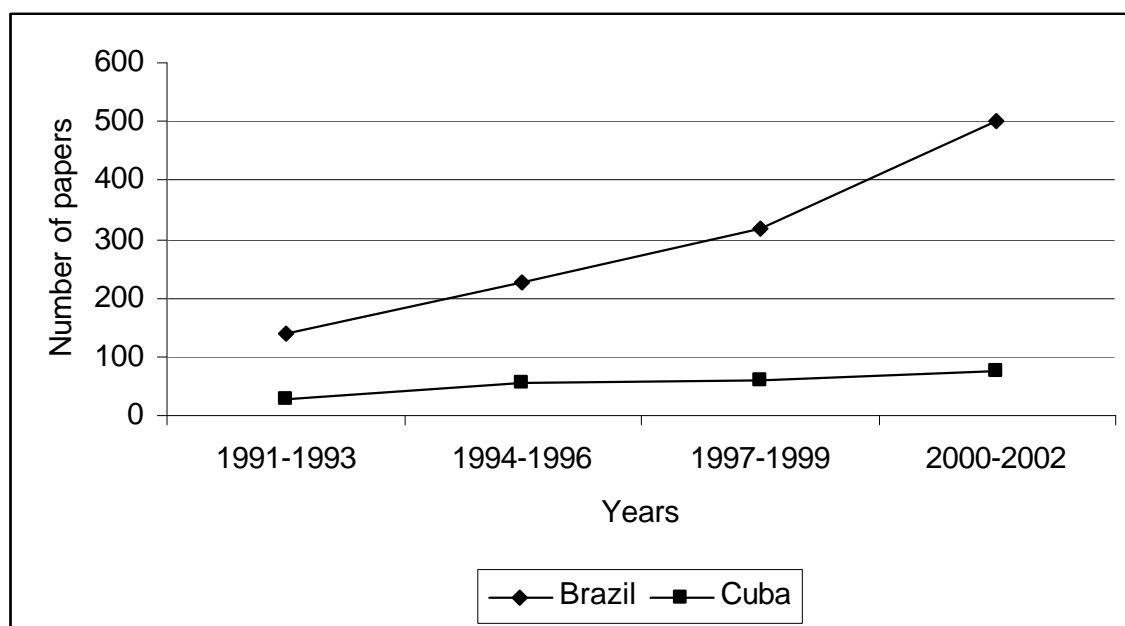


Figure 2: Number of papers in health biotechnology in Brazil and Cuba, 1991-2002
Source: Science-Metrix (data from Science Citation Index Expanded, ©Thomson ISI)

What explains the differences in health biotechnology between Brazil and Cuba

Innovation is a complex process so a multitude of factors and conditions can explain the differences in health biotechnology development between Brazil and Cuba. Here we will briefly highlight a few factors we believe to have played a strong role in shaping the development but a more complete discussion of those factors is beyond the scope of this paper.

1. Governmental involvement.

In Brazil promoting health biotechnology has been the mandate of the Ministry of Science and Technology whereas in Cuba the development of the sector has been under the auspice of the Council of State, the highest decision making power in the country and championed by its President Fidel Castro. As a result the successes in Brazil have been confined to the science and

technology sector and not well aligned with industrial and commercialisation development.

In Cuba the biotechnology sector has had a high national priority and its development has been tightly connected to industrial and foreign affairs policies. An emphasis on health biotechnology fits especially well with the Cuban strategy of promoting health, education and sciences.

2. Domestic linkages.

In Cuba the public research institutes, such as the Centre of Genetic Engineering and Biotechnology (CIGB, Havana), the Finlay Institute (Havana) and the Center of Molecular Immunology (CIM, Havana) are the main actors in health biotechnology. They, for example, published over 97% of health biotechnology papers covered in the international peer reviewed journals from 1991 to 2002 [13]. The institutes cover a breath of activities including research, development, manufacturing, quality control and commercialisation. The fact that all these activities are under the same leadership is likely

to make the knowledge flow and integration between these activities easier.

In Brazil, universities, together with such public research institutions as the Oswaldo Cruz Foundation (FIOCRUZ, Rio de Janeiro) and the Institute Butantan (Sao Paulo), are the main actors in the health biotechnology sector. Universities published 80% of the Brazilian health biotechnology papers in the international peer reviewed journals in 1991-2002, whereas the public research institutes published 31% [13]. Both of the main public research institutes in Brazil share with the Cuban institutes the characteristic of being involved in a variety of activities in health biotechnology which include, for example, manufacturing. Knowledge flow to and from Brazilian universities and public research institutes is, however, limited as they are not well connected to enterprises [7,19]. University professors are often sceptical about close associations with companies and until recently there was a decree prohibiting university professors to be employed by industry. A recent Innovation Law altered this and makes it possible for university professors to work for a limited time for the private sector. As a result knowledge may flow more easily between universities and the private sector in Brazil and the formation of university spin-off companies can be stimulated.

3. Connection with the health system.

The connections between the main actors of the health biotechnology sector and the health system are much better aligned in Cuba than in Brazil. In Brazil, public procurement policies demand that the lowest cost products are purchased by the public health system. This requirement may constitute a responsible public policy but can squeeze out local biotechnology endeavours especially when large multinational companies temporarily underbid local suppliers. The public procurement policy led the health system in Brazil to choose recombinant insulin from Novo Nordisk (Bagsværd, Denmark) over a locally developed product produced by the Brazilian biotechnology company Biobrás. The price difference between these products was small but the decision to purchase led to the downfall of the

Brazilian biotechnology company and ultimately it was acquired by Novo Nordisk [7,20].

Cuba's health biotechnology sector is closely aligned with the health system. Cuban products are preferred to be imported ones in order to save foreign currency. The government has also harnessed the expertise in the health biotechnology sector to address domestic health problems. That was, for example, the case when the meningitis B vaccine was developed. A special research group was formed to come up with a vaccine candidate to address a meningitis outbreak in the country. In general the knowledge flow between the health system and the health biotechnology sector is active and the information from health practitioners has been said to spur innovative ideas [8].

It is evident that Cuba and Brazil have different strengths and weaknesses in the health biotechnology field. There is tremendous scope for them to learn from each other's experience. So far there has been limited collaboration between these two countries in the health biotechnology field. The presidents of Brazil and Cuba have however singled biotechnology out as a field where they intend to promote closer co-operation [22]. From our analysis it will certainly be a mutual advantage for these two countries to collaborate. To combine the scientific strengths of Brazil with the product development expertise of Cuba will be for the benefit of both countries.

Conclusion

In general, the bulk of health innovation in the world is focused on the lucrative markets of the industrialized countries. Limited efforts are aimed at developing countries' health needs. With rampant health problems in developing nations and massive health inequities in the world, it should ultimately be the goal of health biotechnology sectors in developing countries to develop new and innovative health products for their own populations rather than to focus solely on the markets in richer countries. It is encouraging when we observe successes in this respect and see developing countries that have built up impressive capacity to address health needs in this field as is the case of Brazil and Cuba. Still, health biotechnology is a risky field and it is

difficult to predict how these countries will fare in the future. They will face stiff competition from industrialized countries that have actively promoted the biotechnology field for many years. They will also face competition from other developing countries active in this field such as India. It remains to be seen what approach is going to be successful in the long run to follow product led or science led development. In any event these two countries have much to learn from each other and to teach other countries in the region and around the world. Stronger south to south collaboration between countries such as Brazil and Cuba is a promising strategy that can strengthen the rhythm of biotechnology created for and by developing countries.

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