

**BIOCOMBUSTÍVEIS, SUSTENTABILIDADE E POLÍTICAS PÚBLICAS:
A Internacionalização Da Pesquisa Científica Brasileira**

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ABSTRACT

Currently progress is being made in the production and use of biofuels in Brazil and worldwide. This paper is the result of bibliometric research on the topic from two databases: Capes and Science Direct in the areas of energy, environmental sciences and social sciences, during the period of 2009 to 2013 because they are recent studies in this area. The search resulted in 154 articles in Science Direct and 12 articles in Capes. The results underline the importance of public policies for continued growth in the production of ethanol and biodiesel, highlighting the fact that Brazilian scientific production has been published abroad.

Keywords: *biofuels; public policy; biodiesel; sustainability*

1. INTRODUCTION

Climate change has caused many worries around the world because of dependence on fossil fuels, which has led many governments to recognise the importance of promoting sustainable development to address these changes. The promotion of sustainable development occurs, in part, when governments define their policies on energy or introduce biofuels into their national systems of energy production (OECD, 2013b; Pacini, Assumption, Van Dam, & Toneto, 2013). Data from the Organisation for Economic Corporation and Development (OECD, 2013b) shows that the contribution of renewable energy in the total energy supply worldwide was only 13% in 2011, unchanged from 1971 when these statistics began to be published. In OECD countries, renewable energy sources represent 8.2% and in Brazil 44% (OECD, 2013a).

Renewable energy is derived from various sources, the main types being: hydro, geothermal, solar photovoltaic, solar thermal, wind, tidal energy, biogas and biofuels (International Energy Agency, 2011). Biofuels are mainly ethanol and biodiesel (International Energy Agency, 2011; US Energy Information Administration (EIA), 2012). These biofuels constitute a major source of renewable energy in many countries; they are the most widely available (US Energy Information Administration (EIA), 2012) and can answer many of the concerns of governments and societies around the world, among them: (1) reducing the need for imported oil in many countries; (2) reducing dependence on fossil fuels; (3) promoting clean development and (4) promoting rural development and creating new jobs (Kumar, Chaube, & Jain, 2012).

Given these potential answers to many challenges, biofuel production more than doubled in the period of 2006 – 2010, leveraged by public incentive policies in Brazil, USA and Europe. Together, the United States, Brazil, the European Union, China and India demand more than 90% of the biofuels produced worldwide, justified by government policies that encourage production expansion in these regions (International Energy Agency, 2013). In 2013 ethanol production was 120 billion litres worldwide and is expected to reach 155 billion litres by 2020. The production of biodiesel was 27 billion litres in 2013 and may reach 42 billion litres by 2020 (FAO, 2011). Projections by the International Energy Agency for 2035 show that the United States and Brazil will continue as the leaders in the demand for ethanol and biodiesel in the transport matrix with 15% and 30% respectively (International Energy Agency, 2013). Besides Brazil and the United States, the European Union is trying to reach a target of 10% for biofuels in their transport matrix by using the 2020 guidelines on the use of renewable energy established in 2009 (Smyth, O Gallachóir, Korres, & Murphy 2010).

It is projected that by 2020 Brazil will be the second largest producer of ethanol, reaching 51 billion litres and representing 28% of the world production of this commodity (FAO, 2011). The Institute of Applied Economic Research (IPEA, 2010) indicates that until 2002 Brazilian ethanol exports were insignificant; however, owing to the increase in international demand, export volumes rose from 516 million litres in 2002 to almost 5 billion litres in 2008/2009. There has been an increase in the trade of ethanol between Brazil and the United States and the US import of Brazilian ethanol could reach 16 billion litres by 2020 (FAO, 2011). This demonstrates that the search for renewable energy sources that are less harmful to human health and the environment worldwide places biofuels as an alternative for developing a new standard for the world in general and Brazil in particular.

In relation to biodiesel, it was not produced in Brazil until 2005 (Brazil, 2005; Garcez & Vianna, 2009), in 2008 production was 1.17 billion litres, placing Brazil in fourth position worldwide (IPEA, 2010), and it is now nearly 3 billion gallons according to the National Agency of Petroleum, Natural Gas and Biofuels (ANP, 2014th). ANP data from 2014 indicates that there are 63 licensed plants producing biodiesel in Brazil. This growth of Brazilian biofuel production is due to the National Program for Production and Use of Biodiesel (PNPB), which is the regulatory framework of the national market, and which has set the goal of blending biodiesel with fossil diesel (Ferreira & Passador 2010). Although the program only went into effect in January 2005 (Brazil, 2005), since this period there has been significant growth, as is evident from the data presented. This growth allowed the government to anticipate a 5% blend of biodiesel with fossil diesel for January 2010, which was only scheduled for legislation in Brazil in 2013 (Brazil, 2005).

There are also economic benefits generated by biofuels, which have the potential to generate opportunities for sustainable economic development in response to the global economic crisis (International Energy Agency, 2013). Biodiesel, for example, in 2011 contributed more than 7 billion dollars to the country's GDP, and has generated 86 000 jobs (FIFE-APROBIO, 2012a). Data from the Federal Government indicates that in 2009 there were over 50 thousand farming families involved in the production of raw materials for the production of biodiesel (Brazil, 2010a). These data are reflections of the National Program for Production and Use of Biodiesel, which since 2005 has encouraged the production of biodiesel through the participation of family farmers (Ferreira & Passador 2010).

Biofuels offer numerous benefits related to energy security, economic development and the environment in comparison to fossil fuels, but at the same time many challenges must be overcome to achieve these benefits, as they are surrounded by questions related to the sustainability of their production (Hoekman, 2009; Perimenis, Walimwipi, Zinoviev, Müller-Langer, & Miertus, 2011). There is growing concern about the direct and indirect impacts related to land use and the competition with food production. These concerns have led to the search for a global certification of biofuels to ensure that sustainability is a precondition for its production (Tomei & Upham, 2009). Doubts about the sustainability of biofuel production in Europe have led to proposals to reduce the usage limit of biofuels derived from grains for human consumption in European Union countries (International Energy Agency, 2013).

In the case of Brazil, biofuels, especially ethanol and biodiesel, have been established as a very important vector of development for the Brazilian economy. Data from the União da Agroindústria Canavieira de São Paulo (ÚNICA) showed that in 2007, 425 million tons of sugarcane were produced in the 2006/2007 harvest, with a projected 728 million in the 2012/2013 harvest, representing an increase of 71%. Areas for the production of sugar cane for ethanol production have expanded dramatically over the past three decades, especially in recent years, reaching nearly 9 million hectares in 2009 (Kohlhepp, 2010). This growth favours the internationalisation of ethanol, but it requires the efforts of various stakeholders: government, private sector and, in particular, Petrobras, to demonstrate to the world that this performance will not cause the environmental and social damage of which the industry has been accused (Abromovay, 2008). According to Kohlhepp (2010), this accusation comes mainly from oil lobbyists, parts of the automobile industry and European biofuel producers who fear Brazilian ethanol exports, which also involve some non-governmental organisations.

While ethanol is produced only from sugar cane in Brazil, which generates environmental concerns owing to the use of a large-scale monoculture and competition with crops intended for human consumption (La Rovere, Pereira, & Simões, 2011), biodiesel can be made from a wide range of raw materials. ANP data, however, shows that 71.71% of biodiesel production has been from soybean (ANP, 2014th), a cultivation that, besides being intended for human consumption, also causes environmental concerns, since its production is also only viable when produced on a large scale. The production of soy-based biodiesel also occurs in other countries that are major producers of soybeans and biodiesels, as is the case in Argentina, where the commodity is the main raw material for the production of biodiesel (Tomei & Upham, 2009).

It is clear that from the point of view of innovation in the harnessing of other materials that are not competing with food products or the development of other more productive materials, such as palm, palm oil, castor bean and jatropha, it is too early to point out their comparative advantages. However, countries such as China, followed by India and some African countries, have opted to invest in sources of raw materials that are not competing with food products such as jatropha (Ju and Chen, 2011).

Abromovay (2008) highlights the fact that environmental concerns have caused an increase in stakeholders in the biofuel sector, among them trade unions and many social organisations that began to interfere more in the negotiations of the sector, such as the WWF, Conservation International, The Nature Conservancy, Imaflora and OXFAM, highlighting that these stakeholders began to assume increasing importance in the sectorial organisation for one decisive reason: the transformation of Brazilian ethanol as a commodity depends not only on its price competitiveness and its positive energy balance, but also its sustainability. The same goes for biodiesel, which seeks consolidation in the market, but this cannot occur at a high social and environmental cost. With regard to environmental issues, the Plano Nacional de Agroenergia (PNA) emphasises adherence to environmental policy integration with the provisions of the Clean Development mechanism of the Kyoto Protocol, with increased use of renewable energy sources with lower emissions of greenhouse gases (Embrapa, 2006).

Given this background of the development of biofuels, how has the production of knowledge evolved in relation to the biofuels topic? What research has been made on biofuels in Brazil and in the world? What has been the focus of researchers' concerns? Which countries and institutions are doing research on the topic? To answer these questions the aim of this work is to identify and present what has been researched and published on biofuels in two major databases of scientific research, one being national and the other international.

2. BIOFUELS AND PUBLIC POLICIES

The search for models of sustainable development has contributed to an increase in the production of biofuel in Brazil and worldwide (FAO, 2011; International Energy Agency, 2011, 2013), which responds to concerns that the use of fossil fuels is one of the sources causing climate change. There are many reasons for incentives in the production of biofuels, among them issues of energy security, environmental concerns, foreign exchange savings and economic issues related to the rural sector (Demirbas, 2008). There are also many advantages of biofuels; among these is the fact that they are available from common biomass sources; they represent a cycle of carbon dioxide during combustion; they are environmentally sound; they have many environmental and economic benefits for their consumers; and they are biodegradable, which contributes to sustainability (Demirbas, 2008).

Corn, wheat, sugar beet and potatoes are primarily used for the production of ethanol and rapeseed, soybean, sunflower and palm are primarily used for the production of biodiesel (Demirbas, 2008). In Brazil ethanol is mainly produced from sugar cane and biodiesel is produced from a greater variety of sources such as soy (still the main source), but also beef tallow, cottonseed oil, palm and palm kernel (ANP, 2014a). Besides these there are other alternative raw materials still unrepresented or not commercially available such as castor and jatropha, as these are still in the research phase.

Initial efforts to produce biofuel in the world mainly use ethanol by fermenting corn sugar, but technological advances provide a new focus on second-generation biofuels that are produced from a wide variety of biomass sources (Hoekman, 2009). In Brazil, since the start of ethanol production in the 1970s, sugar cane has always been its main raw material. New challenges include the quality of biofuels and the requirements of mixtures, distribution and storage. Considerable efforts in research and development, policy and regulation should focus beyond energy production and on the environmental consequences of biofuels (Hoekman, 2009).

One of the alternatives in the case of Brazil is to use the enormous potential of the Amazon region where there are lots of native plants, different soil conditions and the climate for a high yield of raw materials for biofuels alongside social and environmental benefits too. There is also significant potential, yet to be evaluated, for small communities to extract oil from nuts available locally and many other plant types that can provide raw material for the production of oil (La Rovere et al., 2011). Given the technology available and the availability of land and water, Brazil can increase ethanol production without compromising the protection of natural ecosystems and their diversity (La Rovere et al., 2011). But there are concerns that the cane may compete with food production for space, as well as causing pollution due to the burning of plantation in the case of manual harvesting, and other forms of water pollution when washing cane and leaching caused by vinasse (La Rovere et al., 2011). Many of these concerns, however, often come from industries which fear competition from Brazilian ethanol (Kohlhepp, 2010).

In Brazil, in addition to ethanol, biodiesel has great potential to grow, but for this, public policies and investments are needed, as they were for ethanol in the initial cycle. These policies are needed to encourage investment, economies of scale, productivity growth and to enhance their contribution to sustainable development (La Rovere et al., 2011). The authors caution that much remains to be done in Brazil in order to have a consistent regulatory framework. It also seems to be lacking investments in research and the development of raw materials which are not competing with food products such as soybeans, as they have done in China, India and African countries (Ju and Chen, 2011).

In relation to ethanol, most measures indicated by La Rovere et al. (2011) have already been implemented in Brazil, initially at Proálcool, created by the federal government in 1975 through Decree 76.596/75 (Brazil, 1975). The domestic ethanol market is significant, and the mandatory blending of ethanol with gasoline for export to the United States already occurs (FAO, 2011). For biodiesel, from 2005 the government launched the National Program for Production and Use of Biodiesel (PNPB) to promote the structuring of the internal market for this product and to encourage the participation of family farming in the supply of raw materials for producing companies (Ferreira & Dowel, 2010; Garcez & Vianna, 2009). The results are the growth of domestic production (ANP, 2014b), an increase in GDP and the labour market (FIFE-APROBIO, 2012b) as well as the inclusion of family farmers in the biodiesel production chain (Brazil, 2010b; Ferreira & Dowel 2010) and the promotion of regional development in the semi-arid areas of the North and Northeast regions (Garcez & Vianna, 2009).

It is noticeable that the advances in the production and use of biofuels in Brazil and around the world are leveraged by government policies and incentives which should contribute to the continued growth of the production of the main products: ethanol and biodiesel (FAO, 2011; Ju & Chen, 2011; Smyth et al., 2010). Another fact which indicates the growth of the field is the number of scientific publications, which soared during the period of 2003-2012 (Yaoyang & Boeing, 2013). These authors indicate that the United States is leading the research on biofuels, especially in collaboration with China, the UK, Germany, Canada and South Korea. Yet, according to data from Yaoyang and Boeing (2013), the University of São Paulo (USP) came in 12th place out of the 20 universities that have produced and published the most on biofuels in the world, and Brazil came in 5th place out of all countries.

3. METHODOLOGICAL PROCEDURES

This is a bibliometric study using data from two databases: Capes (national articles only) and Science Direct in the areas of energy, environmental sciences and social sciences. You can find under the title 'Keywords' the summaries of the following keywords: 'biofuels and public policy', 'biodiesel and public policy' and 'biofuels and sustainability'. The motivation for the choice of these two databases is owing to the fact that the Science Direct indexes many of the leading journals in the fields of energy and sustainability, such as Renewable and Sustainable Energy Reviews (impact factor: 5.627), Applied Energy (factor impact: 4781), Bioresource Technology (impact factor: 4.750), Renewable Energy (impact factor: 2.989), Biomass & Bioenergy (impact factor: 2.975) and Energy Policy (impact factor: 2.743). Capes was chosen for the fact that it has a database that brings together the major national newspapers, such as RAP, RAC, RAI, RAE etc. The choice of the five-year survey period from January 2009 to December 2013 was made because it includes recent studies on biofuels in Brazil.

The bibliometric method can be used to explain and interpret the behaviour of a field of knowledge by considering the objects, agents, events, products and contexts of such activities, as entities that can be counted, measured and quantified (Borgman & Furner, 2002). One can also understand it as a method used to demonstrate how a particular field of knowledge behaves by counting the number of publications, the number of authors, types of work, home institutions and other relevant published information in a particular field and during a specific period. In other words, it is a quantitative technique and a statistical measurement of rates of production and a dissemination of knowledge (Araújo, 2006).

Yaoyang and Boeing (2013) conducted a bibliometric study in the field of biofuels based on the *Science Citation Index Expanded Web of Science* to map the research activities and the overall trend in the field of biofuels. Therefore, it is considered that bibliometrics is a suitable technique for the purposes of this study, considering that one wishes to know how the field has evolved to produce knowledge on biofuels in two databases, one national and the other international. For this work, however, databases, objectives and criteria different from those used by Yaoyang and Boeing (2013) were used.

Research results from Science Direct returned 154 articles, of which 29 were discarded because they did not fit the profile of researched articles. In a survey by Capes, 12 articles related to the theme of this research were found. The main categories analysed in these articles were: periodical, year of publication, topics addressed, work objectives, the country of origin of the author(s), institutions of the author(s) and the nature of the studies, empirical, theoretical or theoretical/empirical.

4. RESULTS

In this section, the results of the survey are presented. For the presentation of the data, figures were prepared to support the analysis of this work. Firstly a comparative analysis was carried out on a national and international basis, and it was possible to compare them, taking into account the huge discrepancy between the data found in both databases in relation to the research topic. Following this, an individual analysis of the variables adopted for research in both databases was made.

When comparing the two databases, it is observed through the work found that in Brazil there are few periodicals specifically devoted to publishing papers on renewable energy, including biofuels. While at Science Direct 125 related topic papers were found, at Capes only 12 were found within the adopted criteria (Figure 1). This result demonstrates the mismatch between national journals in the field and a national survey showed that the largest number of papers is in international research, as is also shown in this section. In the case of the international database, there is a strong upward trend in the number of publications, as Yaoyang and Boeing (2013) observed while performing their bibliometrics in another database of references, although 2012 presented a decline for reasons that cannot be evaluated in this work. It seems, however, that this decrease does not invalidate the trend of strong growth in the overall period of analysis.

On the other hand, results from the national database, besides presenting few published studies, representing around 10% of the international database, show no growth trend during the period, as can be seen in Figure 1. It can be noted from this analysis that the number of publications on a national basis does not reach half of the publications of Brazilian researchers in international periodicals. This data indicates that the research area is included in the international context, perhaps because the topics of renewable energy in general, and biofuels in particular, are of international interest. The major countries in the world producing and consuming bioenergy invest in public policies supporting the production and consumption of bioenergy (FAO, 2011), which also seems to have an impact on scientific research.

When analysing which institutions the primary authors of Brazilian work published in international periodicals come from, it can be observed that they come mainly from UFRJ, with five pieces of work, Unicamp, with four pieces of work, and USP, with three pieces of work. In the case of work on a national basis, the primary authors are researchers from USP, with half of the publications (6). No work has been found on a national basis where the primary author is a researcher from UFRJ or Unicamp, which shows that researchers from these institutions direct their work to international journals.

In the analysis of the international database, the first aspect that was observed in Figure 2 is the source of most researchers who have produced and published on the biofuels issue. From the data it can be seen that Brazil, with 24 pieces of work, and the United States, with 18 pieces of work, are the leading countries with the most researchers involved in the issue. These pieces of data converge with the importance of these two countries in the production and consumption of biofuels according to official data from international agencies (FAO, 2011; International Energy Agency, 2011, 2013). The number of publications by Brazilian researchers in this rising calls attention because on a national basis only 12 papers were found, which leads to the inference that Brazilian researchers are giving importance to the subject, but directing their publications to international journals as noted in this section.

Still in the analysis of Figure 2 it can be seen that international production of knowledge in the field of biofuels is fairly comprehensive, consisting of the presence of scientific production in major developed countries (United States and most European countries) as well as in major developing countries such as Brazil, China, India and South Africa; these pieces of data converge with the importance of most of these countries in the production and consumption of biofuels (FAO, 2011; International Energy Agency, 2013). The exceptions are Argentina and Australia, which are major agricultural producers of grain, besides the fact that Argentina is the largest producer of biodiesel among the developing countries (FAO, 2011). Australia, despite its position as a major agricultural producer, still has low ethanol consumption, with 1.6% of its products a mixture of gasoline and biodiesel and 2.7% of its products a mixture of fossil diesel. In Australia biodiesel is produced mainly from animal fat (FAO, 2011), which may explain the low interest of researchers on the topic.

Another fact to be noted in this research is the fact that Brazilian publications lead in the number of different publications found (Yaoyang & Boeing, 2013) in research without a time frame. These authors found that Brazil is only the fifth country to do research on biofuels throughout the history of the process of research in this field. From the data found in this study, it is possible to infer that Brazil has increased its scientific output in recent years as a result of the movement of the government and the private sector in the implementation of PNPB, for example (Ferreira & Shifter, 2010).

The papers were classified as theoretical, empirical and theoretical/empirical, as shown in Figure 3. Many theoretical/empirical papers were considered, even if they had only performed laboratory tests for some sort of simulation, very common procedure in the fields of biology and energy, as it was perceived when performing classification. Through classification, it can be seen that most researchers in the two databases did empirical research (empirical + theoretical/empirical). This result is directly related to the wide variety of areas now involved in research on biofuels and renewable energy. In major periodicals there are a number of publications, such as *Renewable and Sustainable Energy Reviews*, and *Energy Policy*, comprising a broad spectrum of areas. The *Renewable and Sustainable Energy Reviews* accept papers in the areas of energy resources (varied sources of renewable energy), buildings and transportation; policy in economic sectors, environmental, energy planning, social aspects and tendencies, as well as papers dealing with environmental impacts and sustainability. The *Energy Policy* accepts papers which discuss political implications of the supply and use of energy in their economic, social and environmental aspects; in other words, they are comprehensive periodicals, which may have influenced the results found.

There is also the fact that investments are made by governments through public policy, for the research and development of renewable energy, particularly biofuels. There are many universities and research centres around the world investing in research for the development of biofuel, which can be proven by the large number of renewable raw materials, which is cited in the studies analysed.

It is further highlighted that while empirical studies are more focused on developing products related to biofuels, the theoretical studies focus more on aspects of positive and negative impacts of the production and use of biofuels. Some examples are those concerned with the competitive use of land with crops aimed for human consumption and those concerned about the environmental impacts of the production of crops like sugarcane for ethanol production (Abramovay, 2008) or soybeans for biodiesel production (Tomei & Upham, 2009).

When comparing the number of publications in each base there is a big difference. On a national basis, 12 published papers were found in 9 different periodicals (Figure 4), while on an international basis 125 papers were published in 25 different periodicals (Figure 5). However, an analysis of the international base shows that 11 journals account for more than 90% of the publications, as shown in Figure 4. It should also be pointed out that while the international base focuses on publications in the field of energy and sustainability, the national base features publications in the areas of agriculture and the environment.

Analysis of the objectives of the published papers allows the observation of other data already demonstrated in this section, for which the focus of the work is the development of renewable energy such as biofuels. An example of this focus is the mention of 21 different kinds of raw materials for biofuel production in more than half the pieces of work, as shown in Figure 6. Of these, a large part, in fact, concerns research production processes and the viability of these sources for the production and consumption of biofuels. An example of this work is the evaluation of oilseeds, grown in Brazil and available for the production of biodiesel, in order to support the discussion on their sustainability. Another section discusses the economic and social aspects related to these raw materials; for example, pieces of work that analyse the environmental, economic and social context, as well as the drivers and impacts of the rising demand for soy-based biodiesel in countries like Argentina. There are others who examine public policies that support the production of bioenergy, highlighting its benefits in countries such as Brazil and the United States.

It is very significant that focus is given to research in the search for alternative sources of raw materials for the production of biofuels, as demonstrated by the number of papers on algae, jatropha and palm, which together account for nearly a quarter of the publications in the international database, in agreement with Figure 6. In the case of the national database (Figure 7), two-thirds of the works addressed issues related to raw materials, and necessarily about their production or viability, but sometimes the work dealt with studies about the identification of social and environmental impacts. For example, some examined the sugarcane industry, as it is important for Brazil's energy matrix, or they tried to analyse variations in agricultural prices due to biofuel development. In some form, issues related to production sources were addressed.

The greater part of the work in the international base is devoted to analysing and discussing public policy, production and analysis of indicators and projections about renewable energy and biofuel, as can be seen in Figure 8, which was elaborated from the objectives of the articles analysed. It is understandable that the focus, considering both analyses already mentioned, such as those related to sources of bioenergy production, is the fact that the research and production of such bioenergy requires public policy support. As discussed in the literature review, all major countries producing bioenergy have policies to support the development of both the production and the market (FAO, 2011; Ferreira & Passador, 2010; OECD, 2011).

These data are repeated in the work in the national base, in which one-quarter of the work discussed public policies and the same number addressed production processes. In other words, both in Brazil and in the international environment, research seems to emphasise the same line of study. The qualitative analysis part of the work allows us to observe that both the national base and the international base strengthen the focus presented in Figure 8. As examples, studies that analyse the PNPB in Brazil can be pointed out, which appear as much in the national base as in the international base; others analyse the biofuel policy in the European Union; the biofuels policy in Ireland, based on the target set by the EU for 2020, the addition of 10% of biofuels to the transport matrix; the biofuels policy in the UK in the light of the EU policy; the agricultural and biofuel policies within the OCDE and the policy to support the production of raw materials for biofuel production in India. Therefore, the presence of governments in promoting bioenergy in general and fuels in particular stands out in several countries.

5. FINAL CONSIDERATIONS

Through the analysis developed in the present study, it can be noticed that there is a direct relationship between the attention that a country pays to the search for sustainable energy sources and the importance given to the scientific research. In other words, it seems that government policies supporting the production and consumption of renewable energy provoke the interests of researchers to seek answers to the challenges presented. The number of studies examining the role of public policies and those that examine the feasibility of material for biofuel production is notable.

It can also be highlighted that there is a small amount of work produced and published in national journals when compared to the number found in the international base, which can be interpreted as the internationalisation of Brazilian scientific production. This is due, in part, to the fact that while in countries like the United States there are several periodicals devoted to the topics of bioenergy and biofuels, in Brazil, specialised journals on the subject seem inexistent, at least in the indexed journals of Capes. It is curious that a country that is emerging as a major producer and consumer of biofuels does not have specialised vehicles for the dissemination of scientific knowledge. It was observed in the results of this research that there is scientific production in Brazil in the field, but this is published in other countries. The national scientific production published abroad is more than twice the entire national production analysed.

It is noteworthy that research on the subject has given attention to the broader concept of sustainability, highlighting the economic, social and environmental aspects. It was not possible to measure the weighting that each of these aspects received in the study, which may be considered one of the shortcomings of the study. Another is the fact that only two databases were studied, although they are fairly representative in the context of scientific research.

A fact worth mentioning is that most developed countries and developing countries are investing in the bioenergy sector. By reviewing some literature and reports from international agencies it is perceived that the United States, the European Union, Brazil, China, India, Argentina and some African countries like South Africa are leading the production, consumption and research of bioenergy in the world.

The role of governments worldwide in promoting bioenergy in general and fuels in particular seems undeniable. However, this fact coupled with the pursuit of scientific research for the development of production processes and raw materials more viable for biofuels also shows that the current models for the production of ethanol and biodiesel still inspire doubts about their viability as well as their economic and environmental sustainability.

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CHARTS

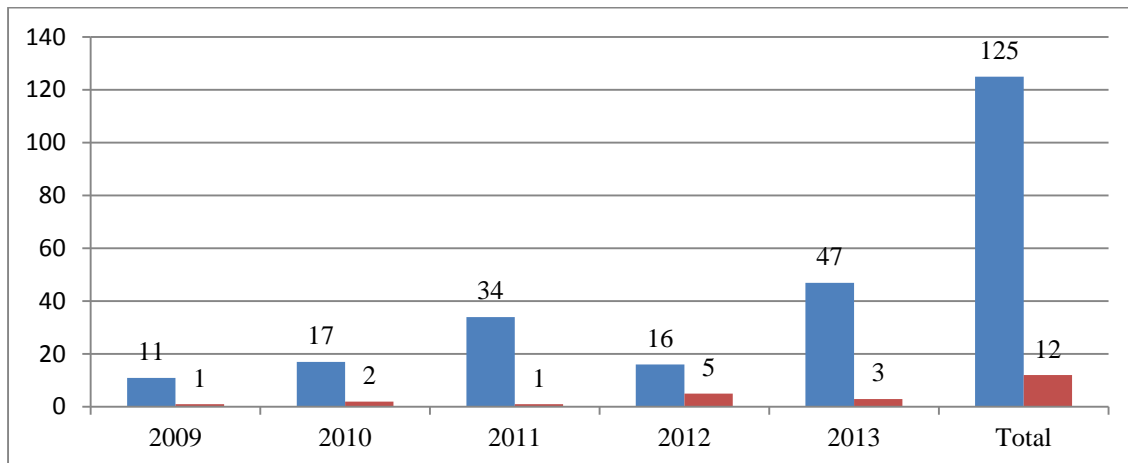


Chart 1- Number of published papers between 2009 and 2013. Source: Data from research, 2014.

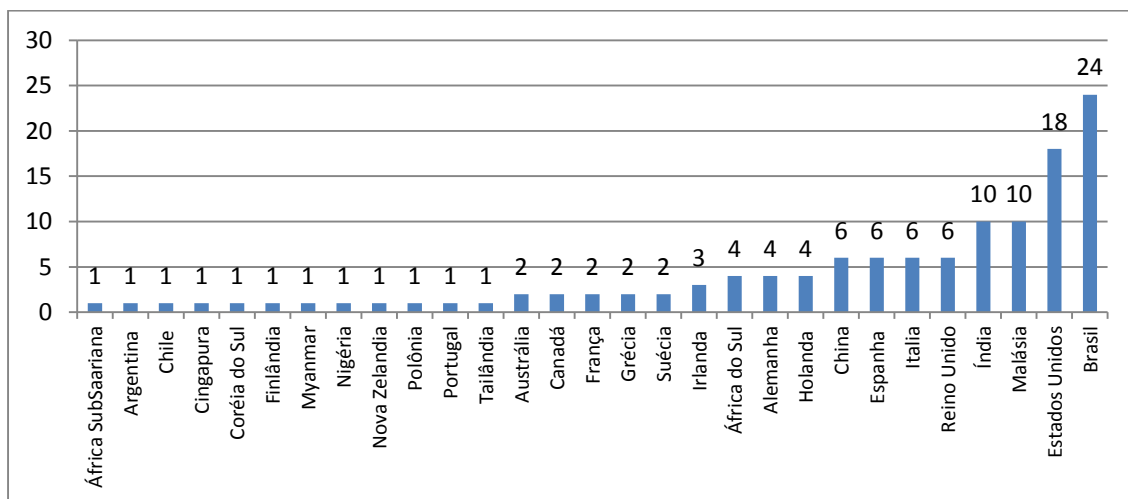


Chart 2- Countries of origin of the analysed articles. Source: Data from research, 2014.

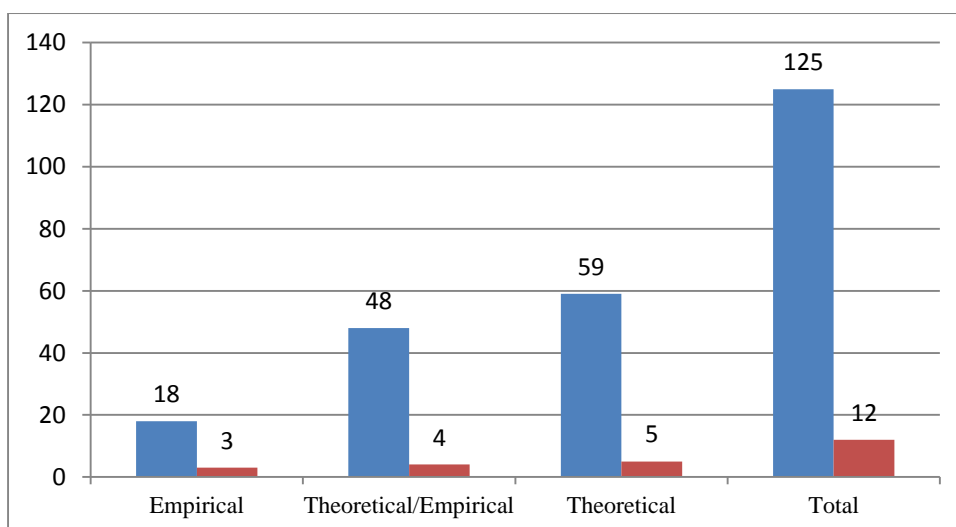


Chart 3- Classification of the papers on theoretical, theoretical/empirical and empirical. Source: Data from research, 2014.

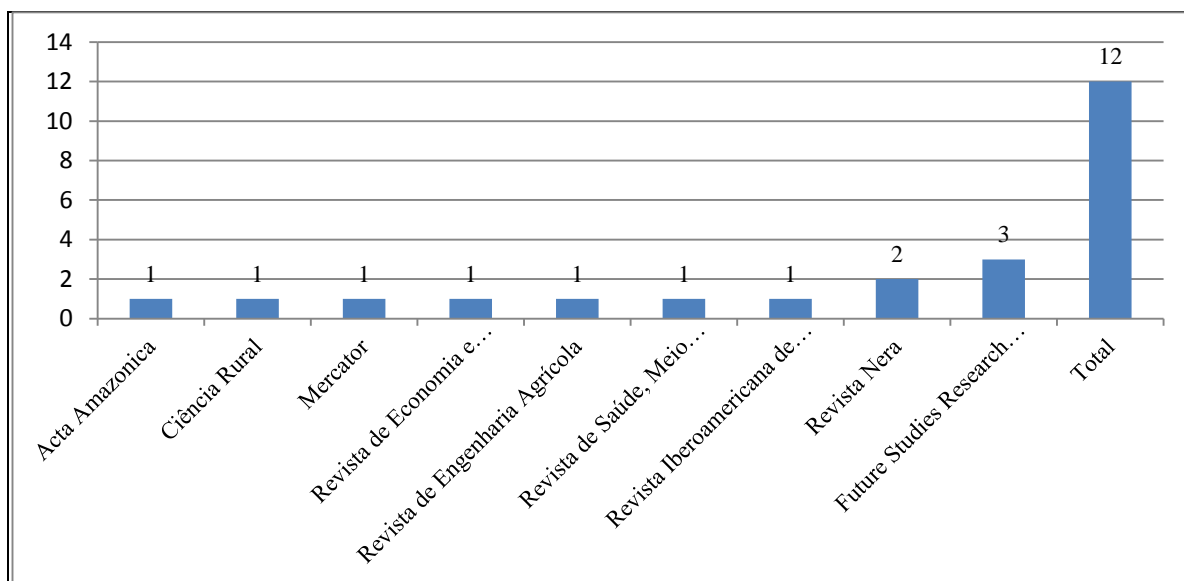


Chart 4- Journals of the Brazilian database. Source: Data from research, 2014.

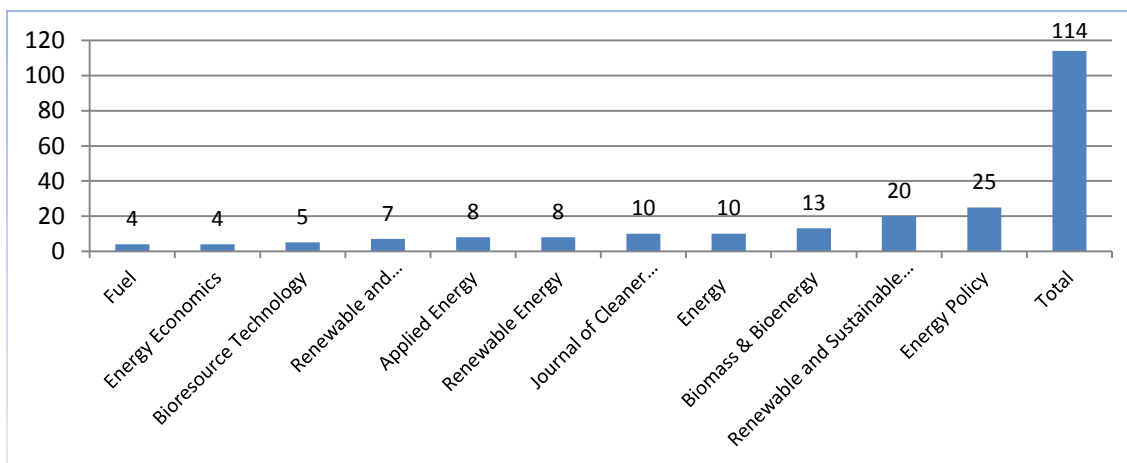


Chart 5- Main journals of the international database. Source: Data from research, 2014.

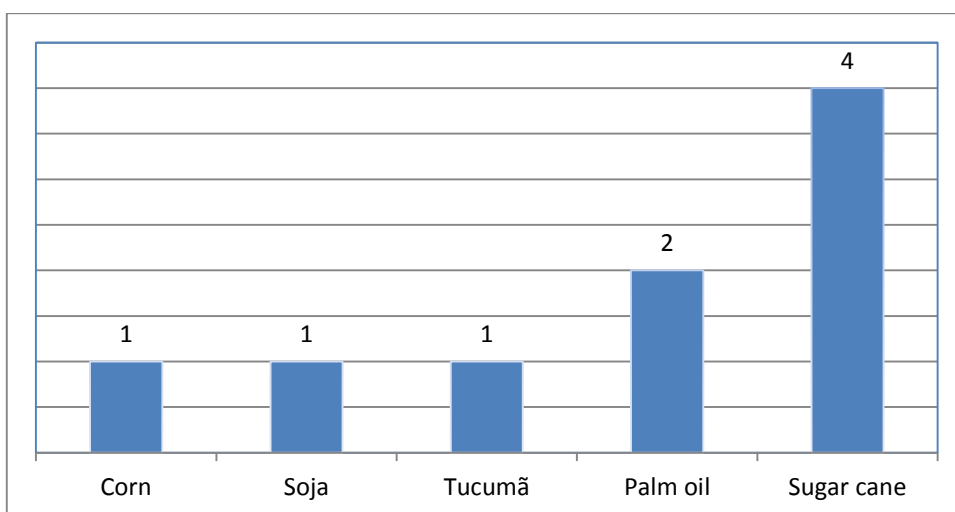


Chart 6 - Raw materials used in biofuel production processes found in national papers. Source: Data from research, 2014.

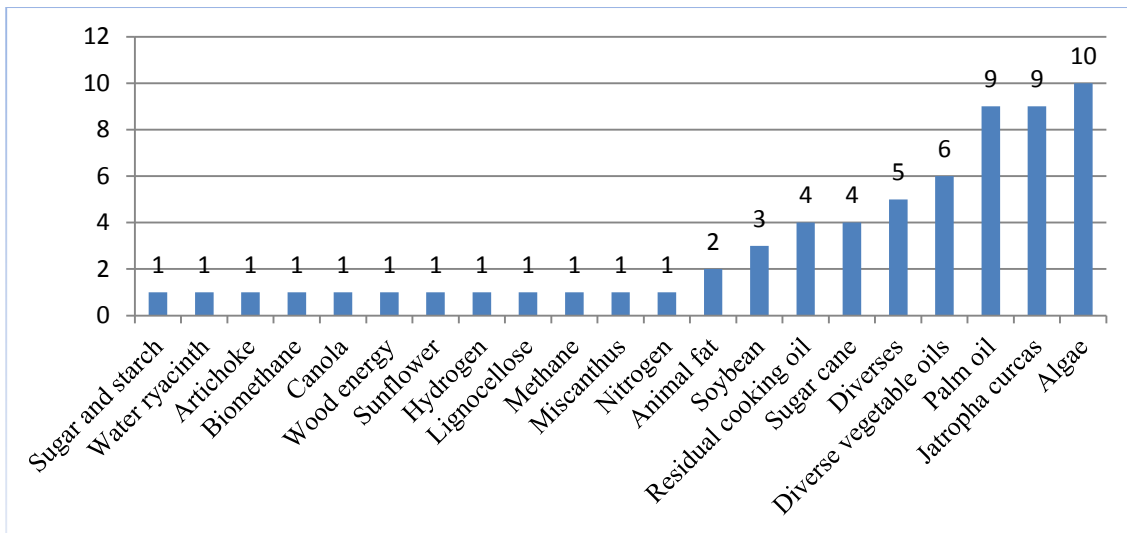


Chart 7 - Raw materials used in biofuel production processes described in the international papers.
 Source: Data from research, 2014.

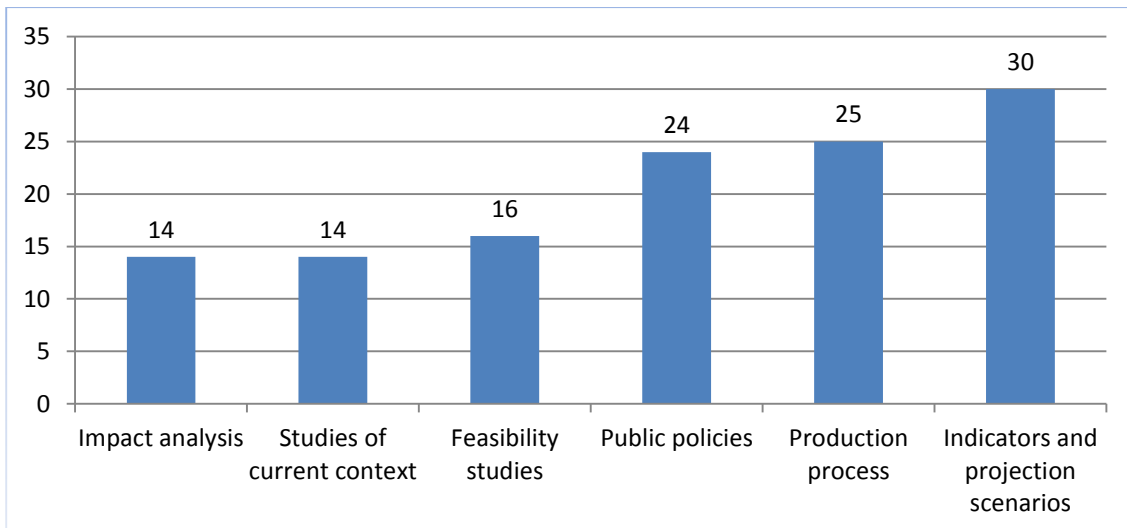


Chart 8- Main focuses of the analysed articles. Source: Data from research, 2014.