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Analysis of Research Trends in Biodiesel as Fuel during Last Decade

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Abstract

This paper presents a bibliometric study focused on the research carried out in the last 11 years on biodiesel as an alternative fuel. Tools such as HistCite were used to manage metadata found using the Web of Science search engine, including author names, titles, abstracts, publication dates, document types, addresses and references cited. In addition, the impact factor and H index of the journals they published were taken into account to analyze the reliability of the research. The study showed a tendency to increase over the years, from 76 publications in 2007 to a total of 2017 in 2017, an increase of 185.71%. Likewise, it was concluded, among other things, that of the 1423 documents obtained to carry out the study, 84.7% were scientific articles, being the majority of the works carried out, followed by the revisions that reached 5.8%. And that magazines such as FUEL, ENERGY & FUEL and ENERGY were among those that contributed the most to this research. In addition, it was demonstrated that the countries most interested in this technology are India, USA and Peoples R China, being these the ones with more than 254, 222 and 119 publications respectively.

INTRODUCTION

The use of fossil fuels has helped us meet our energy needs. This energy source presented an increase of approximately 51% in the period 1995-2015, and consumption is expected to increase by approximately 18% in the period 2015-35. In 1995, oil, natural gas and coal were found to have a total primary energy consumption of 38%, 22% and 26% (87% in total), respectively [1]. One of the consequences of the use of these fuels is the impact on the environment. In Kuwait, the use of crude oil contributes 63% to global warming, although only 12.2% of the energy generated is from crude oil [2].

For this reason, some countries have taken measures to reduce the use of these fuels. In the People's Republic of China, the elimination of fossil fuel subsidies has been implemented, which has contributed well to meeting the aspirations of a low-carbon economy but demonstrated that CO2 mitigation cannot be achieved effectively by eliminating fossil fuel subsidies alone [3]. Similarly, the European Union has recommended measures such as promoting a shift in electricity consumption from peak to peak to valley or valley, storing electricity in different forms, through hydroelectric power stations or thermal storage, increasing the use of electronic vehicles, to create effective vehicle-to-grid and network-to-vehicle strategies [4]. In addition, investment in clean energy has been shown to pay better dividends than investment in fossil fuels [5].

One option for replacing fossil fuels is biodiesel, which has shown a small decrease in NOx emissions compared to diesel at low and medium engine speeds [6]. This fuel is produced by different sources [7]. Microalgae have become an interesting candidate for biodiesel production due to their high growth rate and high oil content compared to crops [8]. In addition, castor oil was studied for production and the results showed that the biodiesel from castor oil in the blends could reduce the value of the cloud point, but at the same time, increase the viscosity of the diesel-biodiesel blends [9]. Likewise, used cooking oil was used [10], sweet potato in Brazil for bioethanol production [11] and waste water was also used to produce biodiesel [12]. In the latter, the cost of biodiesel produced from microorganisms grown from sludge was not competitive with biodiesel from soybean oil (commercial biodiesel); however, this study found

that the cost could be acceptable when sterilization was avoided. Direct fermentation of sludge for lipid production followed by conversion of lipids to biodiesel was in high demand, as it could provide a high amount of sludge reduction as well as a competitive cost as commercial biodiesel [13].

As for its performance, the effect of biodiesel on the performance of internal combustion engines has been studied [14]–[16] using Jatropha curcas, Ceiba pentandra and Calophyllum inophyllum among other sources of biodiesel [17]. A numerical study of the introduction of biodiesel in internal combustion engines was carried out, showing that higher unsaturated biodiesel produces higher soot and NO emissions and that CO emissions decrease with the increase in the value of DU (degree of unsaturation) [18].

Diesel-biodiesel blends are sometimes used, and an ultrasonic method is used to evaluate these blends [19]. For these blends the exhaust soot result was analyzed compared to different types of fuels where it was found that JIS #2 (0% biodiesel), BDF20 (20% biodiesel) and BDF50 (50% biodiesel) fuels are directly proportional to the engine load, while the soot concentration of BDF100 (100% biodiesel) is inversely proportional to the engine load [20]. As for biodiesel from used cooking oil, the specific fuel consumption of biodiesel blends was higher than that of diesel fuel. Higher exhaust gas temperatures were recorded for biodiesel blends compared to diesel oil. CO2 emissions from cooking waste biodiesel blends of petroleum were higher than diesel fuel. CO, smoke opacity and HC emissions for biodiesel blends were lower than for diesel fuel. NO x emissions for biodiesel blends were higher than for diesel [21]. The progress of these studies leads us to identify the contribution of different authors, institutions and countries in the advances presented in this fuel. For this purpose, the most commonly used method to evaluate publications dealing with this subject is bibliometric analysis.

Taking into account all the above, the contribution of this document is directed towards a bibliometric analysis where a qualitative and quantitative evaluation of the trends presented in the world will be made, focused on biodiesel, reviewing documents from the periods shared between 2007 and 2017. Reviewing the metadata found through HistCite on this topic in that time period.

METHODOLOGY

For the acquisition of the metadata studied was used as a search phrase "Biodiesel oily" and the title was assigned as the location of this word and the time was 10 years between 2007 and 2017. The search engine used was Web Of Science, from which all metadata was obtained. As a result of this search, 1423 documents related to the topic were obtained, including the names of the authors, titles, dates of publication, types of documents, abstracts and references cited. For the country of the documents it was determined by the address of the authors and institutions to which it belongs.

Metadata were analyzed taking into account the impact factor, H index, keywords, titles, institutions, countries, journals, language and type of document. The impact factor for the journals that most published on the subject was consulted by means of the information in the publishing house to which it gives rise. This value was taken from the year 2016. Likewise, Scimago was used to take the data from the H index, which is used as a measure of the quality of the journal in which it has been published, this data helps us look at both the quality and reliability of the publications. For the collaborations between authors we used VOSviewer which helped us to quantify these aids and show them in a graphical way.

RESULTS AND DISCUSSIONS

The countries' research activity on this subject speaks volumes about their interest in a transition to this energy source. India is the country that had the highest scientific production concerning this issue reached its peak of production in 2016 where it reached a percentage of 47.9%. In addition, the study of biodiesel shows a progressive increase over the years, as can be observed in the Figure 1.

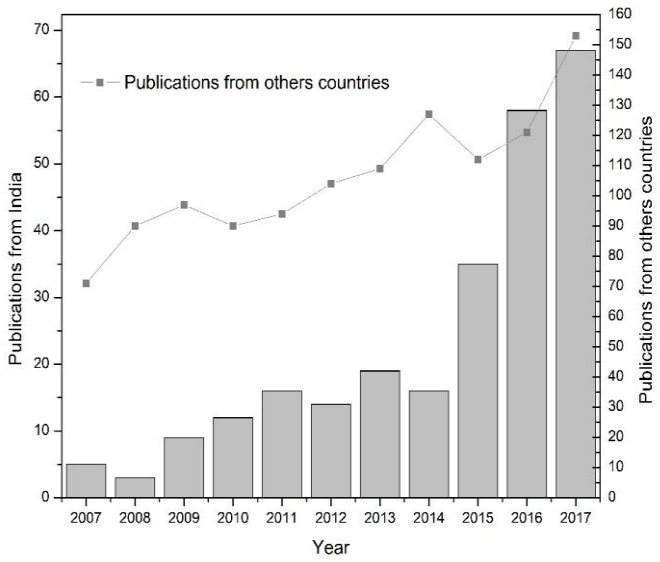

Figure 1. Publications in India compared to other countries

Another clear example of the increase in research over the years can be seen in Table 1 which shows that from 2014 onwards, 10% of publications will be exceeded, reaching 15% in 2017, demonstrating that the trend will continue until the end of the years studied, suggesting that it is possible to maintain this increase in research in future years. Likewise, this table shows that the publications of the first 3 years exceed 4000 TGCS, showing themselves as the documents that have driven the growth of this research topic.

Table 1. Publications per year

PUBLICATION YEAR	RECORD	PORCENT	TLCS	TGSC
2007	76	5,34082923	553	4445
2008	93	6,5354884	757	5620
2009	106	7,4490513	701	5748
2010	103	7,23822909	506	3616
2011	110	7,73014758	499	3544
2012	118	8,29234013	335	2595
2013	128	8,99508082	342	2497
2014	143	10,0491918	308	2561
2015	147	10,3302881	220	1489
2016	179	12,5790583	151	1239
2017	220	15,4602952	57	645

Similarly, table 2 shows the top 8 nations with the highest production of articles on the subject. It can be seen that the USA follows India very closely in the total of publications, but the TGCS (Total Global Citation Score) shows that US articles have a greater global impact given that they are the most cited in the world followed by India and later Turkey being this order different from the largest number of publications. This tells us a little about the quality of the work done by each of these countries

Table 2. Top 8 of countries with the most publications

COUNTRY	RECORD	TLCS	TGCS
INDIA	254	692	5081
USA	222	595	5739
PEOPLES R CHINA	119	505	3357
TURKEY	117	663	4178
JAPAN	95	96	1413
MALAYSIA	90	324	2211
BRAZIL	74	148	1425
SOUTH KOREA	71	299	1575

On the other hand, of the 1423 documents obtained to carry out the study, 84.7% were scientific articles, being the majority of the works carried out, followed by the revisions that reached 5.8%. The remaining 9.5% of the documents are made up of meeting abstract, Proceeding paper, editorial material, letter and correction.

In the same way, the activity of the magazines that have published most about biodiesel was analyzed. Figure 2 shows the FUEL journal as the one with the highest number of publications, only surpassed in 2007 by ENERGY with 16 publications compared to 7 by FUEL, in 2008 by 14 and 12 publications by ENERGY & FUEL and ENERGY respectively. And finally, ENERGY & FUEL surpassed it in 2010 with 12 publications compared to 8 by FUEL, after this, this journal maintains its largest number of publications reaching 33.84% of publications in 2017.

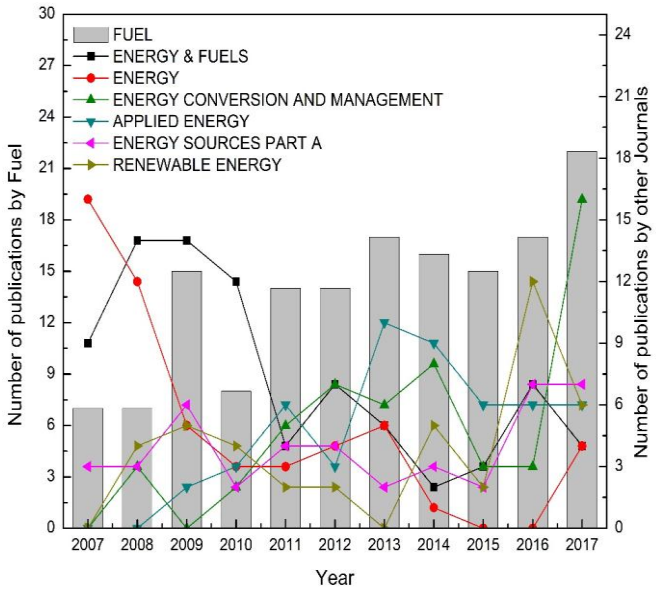

Figure 2. Publications in journals over the years

In addition, table 3 shows the top 8 journals with the most publications in the 11 years. Although FUEL is the journal with the largest number of publications and the largest number of TGCS the magazine that stands out for its greater reliability is RENEWABLE & SUSTAINABLE ENERGY REVIEWS which enjoys a better ranking than the rest of the journal, this magazine has an H index of 193 and an impact factor of 8.05 showing that in general its publications are the most cited.

Table 3. Top 8 journals with the most publications

JOURNAL	RECORD	PERCENT	TLCS	TGCS	H index	IMPACT FACTOR
FUEL	152	10,6816585	826	5251	165	4,601
ENERGY & FUELS	81	5,69219958	357	3104	146	3,091
ENERGY	53	3,72452565	251	1571	146	4,52
ENERGY CONVERSION AND MANAGEMENT	53	3,72452565	391	2582	147	5,589
APPLIED ENERGY	51	3,58397751	316	2175	140	7,182
ENERGY SOURCES PART A-RECOVERY UTILIZATION AND ENVIRONMENTAL EFFECTS	43	3,02178496	29	329	33	0,527
RENEWABLE ENERGY	42	2,95151089	345	1796	143	4,357
RENEWABLE & SUSTAINABLE ENERGY REVIEWS	37	2,60014055	199	1706	193	8.05

Likewise, the institutions that have presented the most research on biodiesel were reviewed and the first place of the publications is the University of Malaya in Malaysia, as shown in Figure 3. This represents 3.2% of the publications made by the 1162 institutions that contributed to this study. This institution reached its peak of publications in 2015 with 14 publications, which is the highest value reached by an institution in the 11 years of study.

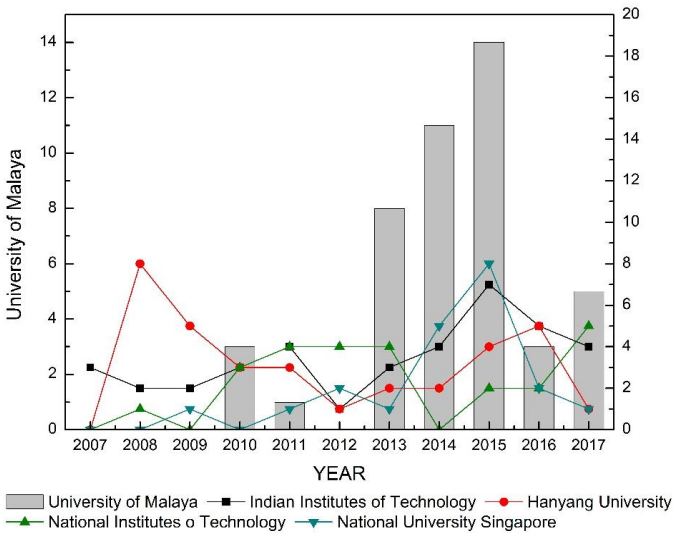

Figure 3. Publications by institutions

This institution began to publish articles on the subject in 2010 with 3 papers in 2012 stopped publishing and from 2014 onwards was not surpassed in publications until 2016 showing a different behavior being 2013, 2014 and 2015 the years that contributed most to reach the top of the institutions that have researched more biodiesel.

On the other hand, the authors with the greatest number of researches on biodiesel are illustrated in Figure 4. In this one it can be observed that Masjuki, in spite of being the author with the greatest number of publications in the 11 years studied only until 2013, made his debut in the subject. In that year, he published 5 articles on Biodiesel, representing 3.9% of what was published in that year. This author reached his highest weighting in 2015 when his publications represented 7.48% of the research on the subject in the world. As for citations Masjuki is the second most referenced with a total of 1112 TGCS, being surpassed by Agarwal with 1782 TGCS demonstrating a higher quality in their publications since despite having 6 less investigations has 670 citations but speaking very well of the work of Mr. Agrawal.

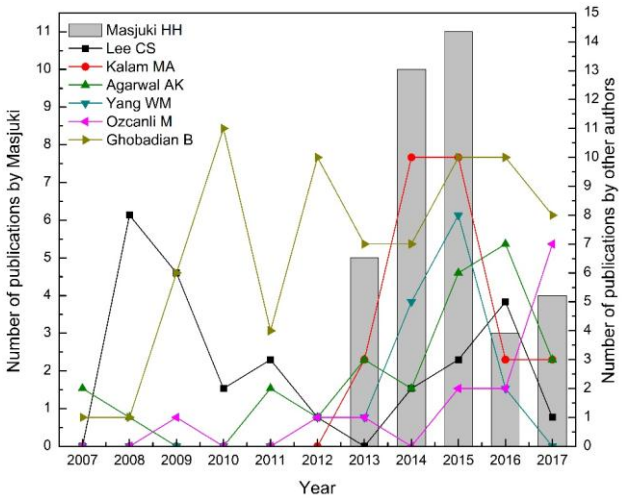

Figure 4. Number of publications by author

Finally, collaborations between authors were analyzed. These collaborations are represented graphically in Figure 5. It shows us Wang X and Huang Z as the main collaborators between authors.

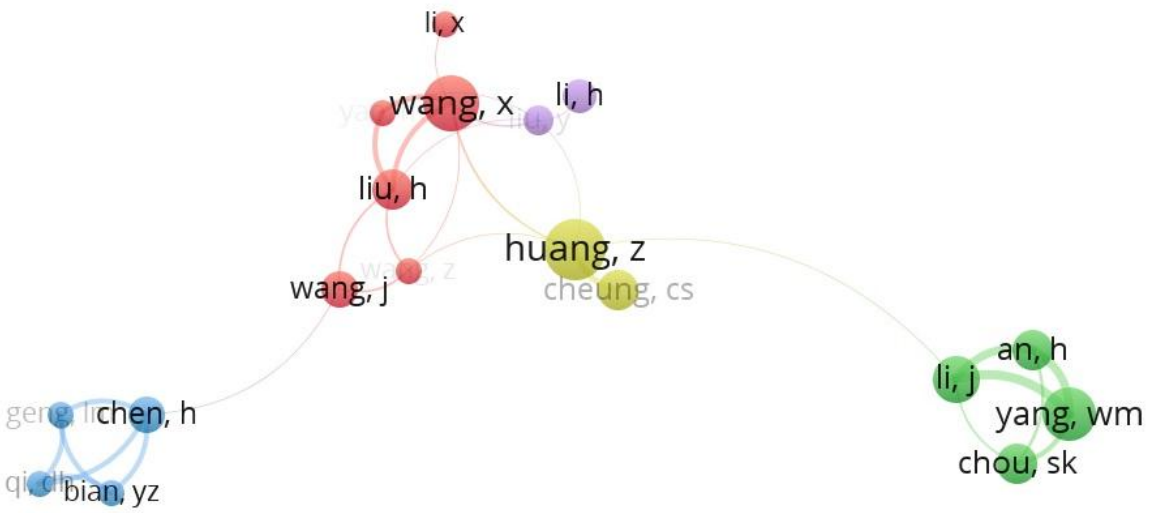

Figure 5. Collaborations between authors

Also, this shows us how the authors with the greatest number of publications do not appear in this figure, being this very striking because despite having a greater number of researches carried out, it shows their little desire to share and receive help to generate an advance in biodiesel technology.

CONCLUSION

Finally, this study has concluded that biodiesel research has increased in quality and quantity in recent years. This increase follows global needs in seeking alternatives to fossil fuels as they contribute a lot to generating the greenhouse effect.

India being the country that carries the flag in research, but the USA being the country with the highest quality of work, obtaining 658 global citations more than India, despite the fact that India has 32 publications more than the USA. This shows the commitment and quality of the work carried out by these two countries to promote the transition towards the use of this new source of energy generation.

Finally, this increase presented in the last 3 years of this study shows us the high possibilities that this technology will increase in the coming years and become an important fuel for global energy generation.

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