A Bibliometric Analysis of Sugar Beet for Production of Biofuels

**Donaji Jiménez-Islas[1]*, Miriam Edith Pérez-Romero[2,3], Juan Manuel Rivera Ríos[1],
Martha Beatriz Flores-Romero[2]**

[1]Higher Technological Institute of Huichapan, Renewable Energy Division, Biofuels, El Saucillo, Huichapan, Mexico, [2]Michoacan University of San Nicolas of Hidalgo, Faculty of Economic and Administrative Sciences, Ciudad Universitaria, Morelia, Mexico, [3]Higher Technological Institute of Huichapan, Business Management Division, El Saucillo, Huichapan, Mexico.
*Email: djimenez@iteshu.edu.mx

ABSTRACT

The ongoing depletion of fossil resources, the energetic autonomy of countries, soaring prices for petroleum and climate change have stimulated research and development on renewable energy as biofuels. In this work, a bibliometric analysis of the Web of Science database was carried out to identify the research related to sugar beet to biofuels. The equation logistic was used to quantitatively describe the growth of the publication of sugar beet in the biofuels field. The results show that the publications of sugar beet for biofuel have a rate of growth of 0-1898 year^{-1}. Germany and the USA were the countries with high influence for research in the field of sugar beet for biofuels. The journal *Zuckerindustrie* was the referent to publications in the field of study. From 2003 to 2019, the exponential growth of publications was found, this profile of growth can be attributed to the development of renewable energy and the relevance of global warming, security energetic and laws that promoted clean energy. This work shows that the logistic equation can be used to predict the evolution of publications in the field of study.

Keywords: Beta Vulgaris, Beets, Root Beets, Biofuel, Fodder Beet
JEL Classifications: Q16, Q20, Q42

1. INTRODUCTION

Fossil fuel based energy sources are being increasingly depleted (Madhania et al., 2019) and the demand for renewable energy is steadily increasing due to rapid population growth and economic development worldwide (Mujtaba et al., 2020). Nowadays there are many renewable energy resources to replace fossil fuels such as: Hydropower, wind, solar, geothermal and biofuels (Weida et al., 2016; Alemán-Nava et al., 2014).

Biofuels are a type of fuels produced from living plant matter or byproducts of agricultural production (Ziolkowska, 2020; Leu et al., 2012); There are a variety of biofuels available in solid, liquid or gaseous forms (Srivastava et al., 2020), in this sense the most widely used are bioethanol (Putrasari et al., 2016), biodiesel (Ogunkunle and Ahmed, 2019; Bušić et al., 2018), biohydrogen

(Singh et al., 2015). The production of biofuels can be divided into three generations, this distinction is mainly based on the origin and the type of biomass used to produce the biofuels: (i) first generation is now commonly recognized as a threat for the food security since their development could greatly influences the land use dedicated to a single energetic use and, therefore, the world food prices (Nicodème et al., 2018); (ii) second generation biofuels using lignocellulosic biomass such as corn stover, sugar cane bagasse, rice and sugar beet pulp (Li et al., 2020); (iii) Third generation of biofuels do not require agricultural land and potable water resources, in this case with algal biomass whit high oil content (Gajraj et al., 2018). To date, sugar crops are cultivated primarily for the manufacture of sugar and secondarily for the production of ethanol, there are two main sugar crops: sugar cane and sugar beets (Marzo et al., 2019). Sugar beet was identified as a promising feedstock option due to its high land-use efficient

and sucrose content; ethanol potential has been calculated as 100-120 l/ton, also sugar beet production requires low agrochemical inputs relative to corn; inputs intensity is comparable to sugarcane (Langeveld et al., 2014; Alexiades et al., 2017). Sugar refineries generate an amount of byproducts such pulp, leaves and crowns, in the sugar beet industry the beet pulp is the main waste, with 1000 kg of sugar beet gives more or less 500 kg of pulp at 10% dry matter; the sugar beet pulp is used to feed cattle, however, other interesting is as fermentation medium for yeast or ethanol production (Nicodème et al., 2018). Production of sugar from sugar beet is second largest in the world after production of sugar from sugar cane, the most sugar beet produced is in Europe, then in Asia and North America; the farming area covered over 4.5 million ha in the world, including nearly 1.5 million ha in the EU countries (Borysiuk et al., 2019).

There is a wide range of publications in the world using the sugar beet to biofuels, in this case sugar beet as a raw material for bioethanol production using *Saccharomyces cerevisiae* with stillage recycling (Hinková and Bubník, 2013), specialized varieties of *Beta vulgaris* L may be an eligible feed stock for advanced biofuel designed under the USA Energy Independence and Security ACT of 2007 based on a wet beet to ethanol with a cost estimated to compare with the feedstock corn raw (Haankuku et al., 2015), hydrogen production under dark fermentation using sugar beet pulp (Cieciura-Włoch et al., 2020), bioethanol production under stress conditions of *S. cerevisiae* ITD196 using red beet juice (Jiménez et al., 2014), production of biogas using enzymatic pretreatment under co-fermentation of sugar beet pulp silage and vinasse (Ziemiński and Kowalska-Wentel, 2015) and bioethanol from non-sterilized beet molasses and immobilized strain of *S. cerevisiae* under fed-batch culture (Roukas, 1996).

Despite these facts, according to the articles published in the field of biofuels, crops, biotechnology, food or chemical, in general there is limitations nowadays to know the number of works in the world around the sugar beet with applications to biofuels or biomass energy; In this sense, few analyses of research activities have been conducted in the field of biofuels using sugar beet and they can be analyzed using bibliometric methods. Bibliometric reviews are common nowadays and it is defined as the analysis of scientific publications using statistical methods in order to provide a general outline and overall structure of the research area (Andreo-Martínez et al., 2020). Bibliometric methods are employed to examine various publications characteristics such as countries, research universities, journals, research fields and citations (Mao et al., 2015); Also, it is of great significance for the development of biomass energy to put forward specific suggestion and strategies based on the analysis and demonstration of relationship and interdependence between biomass energy utilization and the environment (Mao et al., 2018). The abundance of scientific research along with the numerous reports issued by government agencies reflect the interest and the concern of politics and society on this topic (Hache and Palle, 2019). In this study, a comprehensive bibliometric analysis was used to trace global trends in sugar beet research to biofuels.

2. MATERIALS AND METHODS

2.1. Dataset Used

In this study, the following phrases were used to search titles, abstract and keywords in the database of the Web of Science (WoS): (TITLE-ABS-KEY [biofuel* OR bio-fuel* OR bioethanol OR biodiesel OR biohydrogen OR bioturbosine OR biogas OR bioenergy OR "energy crops"] AND TITLE-ABS-KEY ["sugar beet" OR sugarbeet]). The sign (*) in the search box was used to obtain both singular and plural versions of a keyword, and the marks ("…") were used for exact phrases search. The data were analyzed using Microsoft Excel 2013. Bibliometric indicators were extracted and analyzed both quantitatively and qualitatively. Ethical approval was not necessary, since the data were downloaded from the public databases and did not involve any interactions with human or animal subjects.

2.2. Modeling and Statical Methods

The time trend of the publications was analyzed by fitting mathematical model with Microsoft Excel 2013 and solver function, the logistic growth equation was used to model the profile of document (Jiménez et al., 2014).

$$P(y) = \frac{P_{max}}{1 + \left(\frac{P_{max}}{P_0} - 1\right)e^{-\mu y}} \tag{1}$$

When the symbol $P(y)$ represents the cumulative volume of documents by year, P_{max} maximum number of documents, P_0 initial number of documents, y year and μ specific growth rate of publications.

The data were used to fit all parameters using the solver function on Microsoft Excel 2013, The simulation program was designed to achieve the minimal normalized error using solver function and the data of WoS were fitted to determine the value of specific growth rate (μ); the results of WoS and the generate by model were analyzed using regression curve fitting with statistical significance set at P = 0.05 (Jiménez et al., 2014).

2.3. Network Maps

The data download from WoS was imported into Microsoft Excel 2013 and VOSViewer software which was used to create network maps. The maps were used to analyze the relations among highly cited references and productive authors, cities and universities (Zhai et al., 2018).

3. RESULTS AND DISCUSSION

The results of the bibliometric analysis on sugar beet for production of biofuels based on publications indexed in Web of Science (WoS) will be presented in the following sections. A total of 1052 documents were retrieved from the Web of Science database in the period from 1998 to midway through 2020.

The distribution of document types identified by WoS database were analyzed and the article as the most frequently used document

type, accounting for 78.91% of total, followed by proceedings papers for 11.03%, reviews 6.62%, book chapters 2.29% and other documents 1.15 % (Editorial Material, Meeting Abstract, News Item, Correction, Data Paper, Early Access and Note).

The English (85.84%) was the most frequently used language, followed by the German (8.37%), Czech (4.37%), French (0.38%), Polish, Serbo Croatian, Slovak and Spanish (0.19% each one), Lithuanian, Serbian and Turkish (0.1% each one). The most researchers will publish the research results in English language types in order to facilitate communication and improve the influence of their research (He et al., 2019) and interest in internationalizing the information (Valencia et al., 2018). Moreover, English is the official language for most international conferences (Tsay and Yang, 2005).

3.1. Trends Based on Publication Year

The rate of publications growth was estimated using the logistic equation, the results presented in Figure 1 show that the used equation fit closely to the data of publications obtained in the database WoS, which was confirmed by the determination of the degree of fit between data known and data estimated by the model using the multiple determination coefficient (R^2=0.9132). The logistic equation used to model the profile of number of publications fit very well with the data with the rate of 0.1898 year^{-1}, this can be used in the model to determinate the evolution in the next years in the field of biofuels using sugar beet.

From 1985 to 2001, the number of documents published annually increased by no more than 61 items, in 2002 to 2006 only 67 more documents were published in the main journals. The publications grew rapidly after 2007 with 906 documents. The Figure 1 indicates that the publications of sugar beet to biofuels grow exponentially between 2007 and 2019.

3.2. The Most Influential Countries

The characteristics of the top 30 countries are illustrated in Table 1. The leading country in total publications was Germany (16.41%),
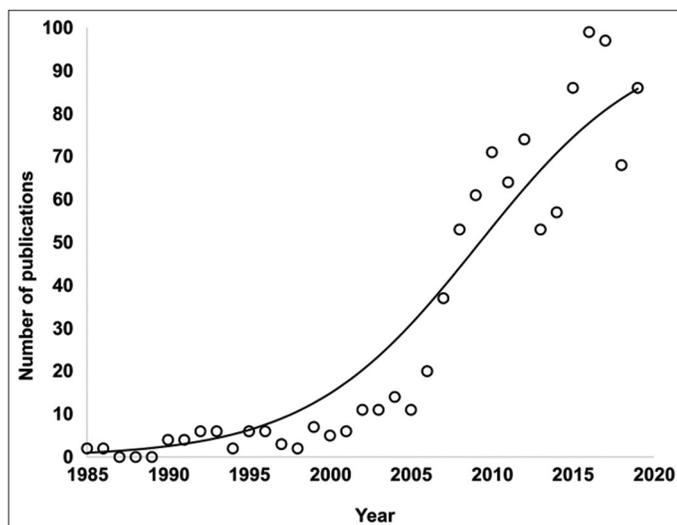
followed by the USA (9.65%), Turkey (6.05%), Netherlands (5.53%), Poland (4.82%), Czech Republic (4.38%) and England (4.12%). The 50 % of publications there are concentrated in the top 7 of countries, Table 1.

The ratio TC/TP of Ireland was 183.20 (the publication more cited was Biofuels from microalgae-A review of technologies for production, processing, and extraction of biofuels and co-products), followed by Netherlands (59.69), Finland (50.63), Sweden (38.70), Australia 37.23, India (31.21), Turkey (30.52); This results indicate that the top countries more influential in sugar beet publications are Ireland and Netherland with 2 and 7 publications >= 100 citations and 1 and 4 publications ≥74 citations, respectively. On this hand, in terms of quantity, Germany accounts for the highest h-index (28), the TP (187), which shows that Germany has the strongest influence on the research of sugar beet.

Country co-authorship analysis can reflect the degree of communication between countries as well as the influential countries in the field, the country co-authorship network is showed in Figure 2. There are many clusters (7) in the map, which shows the diversification of research directions, the big frames represent the influential countries. The links between frames represent the cooperative relationship among institutes and the distance between the nodes and the thickness of the links represent the level of cooperation among countries (Liao et al., 2018). The size of each node in Figure 2, represents the number of publications (Omoregbe et al., 2020), in blue cluster, Germany had the greatest collaboration strength with others cities, in the purple cluster USA and France had strongest network with others countries (France, Chine). This collaboration can be result of the policy in each country to reduce the CO_2 emissions development the renewable energy.

3.3. Co-occurrences of Author Keywords

Co-occurring keywords used by authors were retrieved and analyzed as shown in Figure 3, these keywords were grouped into 5 colored clusters according to similarities in the areas of research. The 10 most occurring keywords were "bioethanol"

Figure 1: Number of publications in sugar beet for biofuels research from 1985 to 2019. (O publications WoS; — model)

Figure 2: The country co-authorship network of sugar beet for biofuels researches from 1985 to 2019
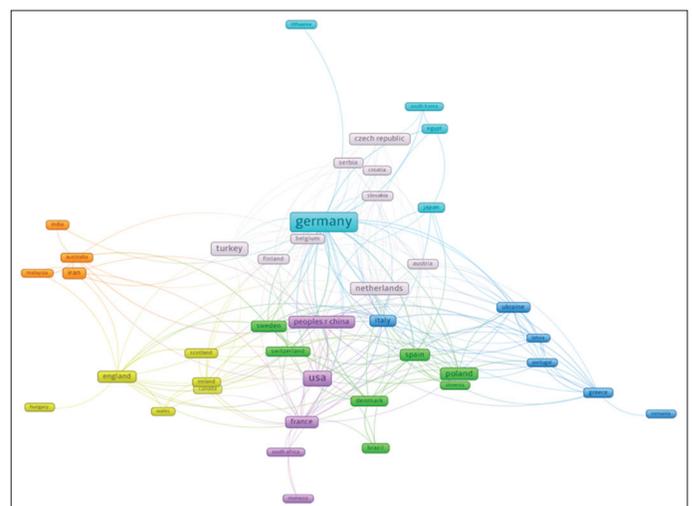
Table 1: The most influential countries of the sugar beet to biofuels

Ranking	Countries	TP	TC	H index	TC/TP	≥100	≥75	≥50	≥25	<25
1	Germany	187	2849	28	15.24	3	4	4	22	154
2	Usa	109	2517	21	23.09	2	1	5	12	89
3	Turkey	69	2099	22	30.42	5	2	1	10	51
4	Netherlands	63	3755	25	59.60	7	4	2	12	38
5	Poland	55	482	12	8.76	0	0	1	5	49
6	Czech Republic	50	208	7	4.16	0	0	0	1	49
7	England	47	1394	21	29.66	4	2	3	11	27
8	People R China	46	561	14	12.20	0	1	1	4	40
9	Italy	43	706	15	16.42	1	1	0	5	36
10	France	42	596	14	14.19	0	1	1	5	35
11	Spain	42	1160	16	27.62	2	1	2	3	34
12	Sweden	40	1548	20	38.70	5	2	3	4	26
13	Iran	37	600	12	16.22	0	2	0	7	28
14	Serbia	29	544	16	18.76	0	0	0	9	20
15	Ukraine	29	20	2	0.69	0	0	0	0	29
16	Austria	23	477	10	20.74	1	0	1	2	19
17	Denmark	22	322	11	14.64	0	0	1	3	18
18	Greece	22	195	8	8.86	0	0	0	4	18
19	Japan	22	372	9	16.91	0	0	3	3	16
20	Brazil	20	499	9	24.95	2	0	1	2	15
21	Switzerland	20	482	9	24.10	2	0	1	1	16
22	Belgium	19	482	10	25.37	1	2	0	1	15
23	Finland	16	810	14	50.63	2	1	3	5	5
24	Ireland	15	2748	12	183.20	2	1	3	2	7
25	India	14	437	7	31.21	1	0	0	2	11
26	Australia	13	484	7	37.23	3	0	1	1	8
27	Croatia	12	98	5	8.17	0	0	0	0	12
28	Slovakia	12	110	4	9.17	0	0	1	0	11
29	Scotland	11	202	7	18.36	0	0	2	1	8
30	Canada	10	239	5	23.90	0	1	2	0	7

Figure 3: Network visualization maps the keywords of sugar beet for biofuels research from 1985 to 2019
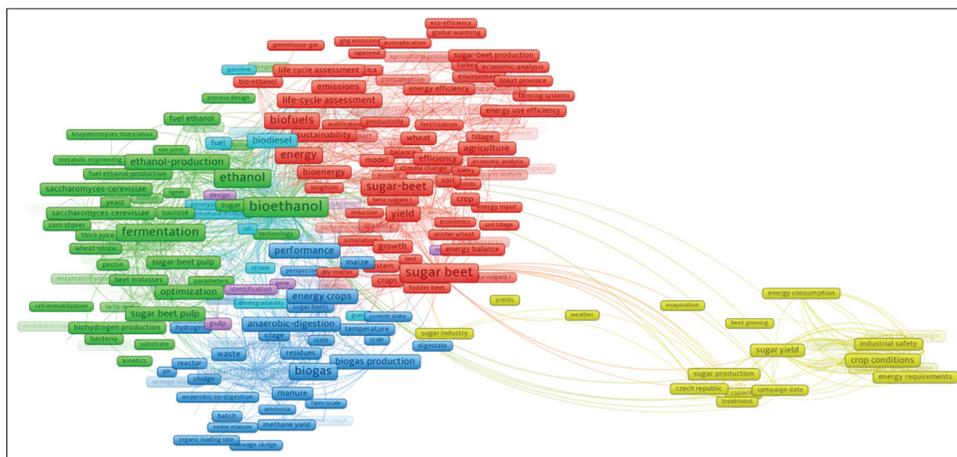
(139 occurrences), "sugar beet" (111 occurrences), "biomass" (108 occurrences), "ethanol" (102 occurrences), "fermentation" (98 occurrences), "sugar-beet" (86 occurrences), "biogas" (85 occurrences), "biofuels" (74 occurrences), "energy" (72 occurrences), and "anaerobic digestion" (71 occurrences). The results from keywords occurrences revealed that research shows a low link between the cluster of crop conditions and the cluster integrated by sugar beet, bioethanol, biogas and biodiesel.

3.4. The Most Productive Institutions

The top 30 most productive institutes are listed in Table 2, the United States Department of Agriculture USDA, Wageningen University Research and University of Novi Sad are the top three institutes. Furthermore, in the top 30 most productive institutes, there are 8 institutes in Germany, and 4 institutes in the USA. Also, through the analysis of Table 2, the Utrecht University has the most productive ratio TC/TP (91.77), followed by Wageningen University Research (55.59), Lund University (52.84) and Institute of Sugar Beet Research (52.63). On the same hand, 11 institutes have more ≥100 cites and Lund University is the leader with 3 publications under this number of cites.

3.5. Journal more Influential in Sugar Beet to Biofuels

As shown in Table 3, the top 30 journals research in sugar beet to biofuels is identified, according to the statistics from Web of Science database. The journal *Zuckerindustrie* has the greatest

**Table 2: The top 30 countries and institutions contribution to publications of the sugar beet to biofuels**

Ranking	Institutions	TP	Countries	TC	H index	TP/TC	≥100	≥75	≥50	≥25	<25
1	United States Department of Agriculture Usda	34	USA	598	11	17.59	1	0	0	2	31
2	Wageningen University Research	29	Netherlands	1612	15	55.59	3	1	0	7	18
3	University of Novi Sad	25	Serbia	514	16	20.56	0	0	1	8	16
4	Inrae	23	France	364	10	15.83	0	1	1	2	19
5	Czech University of Life Siences Prague	21	Czech Republic	61	6	2.90	0	0	0	0	21
6	Inst Sugar Beet Res	19	Germany	1000	10	52.63	1	0	0	1	17
7	Lund University	19	Sweden	1004	16	52.84	4	1	2	2	10
8	Lodz University of Technology	18	Poland	268	10	14.89	0	0	1	2	15
9	University Hohenheim	18	Germany	475	10	26.39	1	0	1	2	14
10	Sudzucker Ag Mannheim Ochsebfurt	16	Germany	107	4	6.69	0	0	1	0	15
11	North Dakota State University Fargo	15	USA	108	6	7.20	0	0	0	1	14
12	Inst Zuckerrubenforsch	14	Germany	69	5	4.93	0	0	0	0	14
13	Helmholtz Association	13	Germany	413	8	31.77	1	0	1	1	10
14	University of California System	13	USA	273	8	21.00	0	1	1	2	9
15	Utrecht University	13	Netherlands	1193	9	91.77	2	1	1	3	6
16	Martin Luther University Halle Wittenberg	12	Germany	445	9	37.08	1	1	0	2	8
17	Swedish University of Agricultural Sciences	12	Sweden	278	9	23.17	0	0	2	2	8
18	Universidad de Cadiz	12	Spain	204	8	17.00	0	0	0	2	10
19	Vuc Praha As	12	Czech Republic	24	3	2.00	0	0	0	0	12
20	Middle Eats Thecnical Universiti	11	Turkey	321	8	29.18	1	0	1	2	7
21	Centre National de La Recherche Scientifique Cnrs	10	France	148	6	14.80	0	0	1	1	8
22	Chinese Academy of Sciences	10	China	81	5	8.10	0	0	0	1	9
23	Leibiniz Institut Fur Agrartechnik Und Biookonomie Atb	10	Germany	367	7	36.70	1	1	0	2	6
24	Naas	10	Ireland	17	2	1.70	0	0	0	0	10
25	University of California Davis	10	USA	149	6	14.90	0	0	1	1	8
26	University of Zagreb	10	Croatia	75	4	7.50	0	0	0	0	10
27	Aarhus University	9	Denmark	112	6	12.44	0	0	0	1	8
28	Agroparistech	9	France	122	7	13.56	0	0	0	1	8
29	Chinese Academy of Agricultural Sciences	9	China	104	6	11.56	0	0	0	1	8
30	Helmholtz Center for Environmental Research Ufz	9	Germany	310	7	34.44	1	0	0	1	7

number of publications with 74 documents, followed by *Biomass Bioenergy* (56 documents), *Listy Cukrovarnicke a Reparske* (39 documents), *Bioresource Technology* (38 documents), *Sugar Industry Zuckerindustrie* (31 documents), the rest with less that 30 documents. It is obvious that the more a country and territory or an institution publish its research findings, the more contributions it will make in the certain research area (Zhou et al., 2018) and the most influential country in the field of sugar beet to biofuels is Genrmany. The journal *Zuckerindustrie* is published in the Germany and during the analysis was found other title *Sugar Industry Zuckerindustrie*, for that reason they occupy the 1st and 6th place in the ranking.

3.6. Co-authorship Analysis

To identify authors with the most published documents about sugar beet to biofuels, VOSviewer was used to extract and analyze the author information. Of all 3214 authors, we can be grouped into three categories by cluster analysis, where each cluster is marked with different color (red, green and blue), Figure 4. It is noted that Koch Heinz-Josef and Maerlaender Bernward have highest publications (12) and also have highest corporation number with other researchers. The most influential research group is cluster red with 4 authors (Koch Heinz-Josef, Jacobs Anna, Goetze Philipp and Christen Olaf), followed by the cluster green with 3 authors (Maerlaender Berward, Hoffmann Crista and Stockfisch Nicol, and the blue cluster with 2 authors (Bahrs Enno and Auburger

Figure 4: Network visualization map authors.
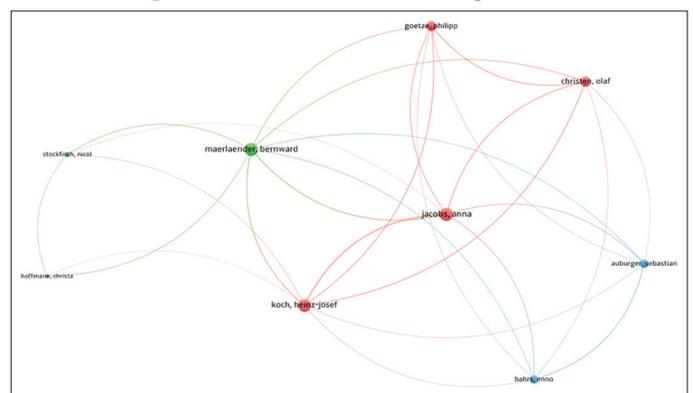
Sebastian); The minimum number of documents of an author was five for the software VOSviewer.

In the analysis of authors Jaroshlav Gebler is the more productive with 13 publications, however, the ratio of TC/TP (Total of Cites/ Total of Publications) were more highest by: Bjorsson Lovisa (29.14), Dodic Jelena (26.5), Eroglu Inci (25.2), Gunduz Ufuk (25.5) and Zhang Ruihong (22.4).

In this work, the evolution of scientific publications had an exponential growth, the research into the main renewable energy

Table 3: The top 30 journals in sugar beet to biofuels

Ranking	Journals	TP
1	Zuckerindustrie	74
2	Biomass Bioenergy	56
3	Listy Cukrovarnicke a Reparske	39
4	Bioresource Technology	38
5	Sugar Industry Zuckerindustrie	31
6	International Sugar Journal	21
7	Journal of Cleaner Production	20
8	Renewable Sustainable Energy Reviews	20
9	Energy	19
10	Energies	13
11	Botechnology for Biofuels	12
12	European Journal of Agronomy	12
13	Industrial Crops and Products	12
14	Remote Sensing	5
15	Rostlinna Vyroba	5
16	Waste Management	5
17	Agricultural Water Management	4
18	Animal Feed Science and Technology	4
19	Chemical Engineering Transactions	4
20	Frontiers in Plant Science	4
21	Journal of Environmental Management	4
22	Journal of the Institute of Brewing	4
23	Rsc Advances	4
24	Soil Tillage Research	4
25	Sustainability of the Sugar and Sugar Ethanol Industries	4
26	Water Research	4
27	Rural Develompment	3
28	Science of the Total Environment	3
29	Scientifiic Reports	3
30	Transactions of the Asabe	3

sources is growing at a sudden rate due to the environmental damage we have all suffered in recent years due to global warming, also that there is great expectation of these technologies for the solution of energy demand.

4. CONCLUSION

This study, we conducted a bibliometric analysis of publications of sugar beet for the production of biofuels from WoS database for the period 1985 to midway through 2020. According to the above analysis, some useful conclusions are derived as follows:

- Of the publications obtained, there is an increase in the research of sugar beet to biofuels with a rate of publications of 0.1898 years^{-1}. The logistic model is a tool that can be used to determine the rate of growth of knowledge in other areas
- The two most important countries publishing research regarding sugar beet to biofuels were Germany and the United States
- In the case of language, around 85.84% of the documents has been published in English, followed by German and Czech. Also, the article was the most frequently used document for publications of sugar beet to biofuels
- The most influential authors in the field of sugar beet are Koch Heinz-Josef, Jacobs Anna and Maerlaender Berward
- A large proportion of documents are published in the journal *Zuckerindustrie*
- The analysis of the co-occurrence of terms led us to observe that the main research areas were Sugar beet and terms related to bioethanol and biogas.

There are some limitations to this study. First, it relies exclusively on articles inWoS database, which might not be sufficient to represent all of the sugar beet literature. Second, this work could be more refined with other areas of knowledge.

This paper provides an overall analysis of the current state and emerging trend in sugar beet in biofuels production researches, which helps people to learn more about the development of the field of bioenergy; also, the policy makers could react to the increasing relevance of innovations and development of renewable energy and the biofuels, where it is necessary appropriate subsidy mechanism to facilitate their implementation (Ochoa et al., 2019).

5. ACKNOWLEDGMENTS

REFERENCES

Alemán-Nava, G.S., Casiano-Flores, V.H., Cárdenas-Chávez, D.L., Díaz-Chavez, R., Scarlat, N., Mahlknecht, J., Dallemand, J.F., Parra, R. (2014), Renewable energy research progress in Mexico: A review. Renewable and Sustainable Energy Reviews, 32, 140-153.

Alexiades, A., Kendall, A., Winans, K.S., Kaffka, S.R. (2018), Sugar beet ethanol (*Beta vulgaris* L.): A promising low-carbon pathway for ethanol production in California. Journal of Cleaner Production, 172, 3907-3917.

Andreo-Martínez, P., Ortiz-Martínez, V.M., García-Martínez, N., de los Ríos, A.P., Hernández-Fernández, F.J., Quesada-Medina, J. (2020), Production of biodiesel under supercritical conditions: State of the art and bibliometric analysis. Applied Energy, 264, 114753.

Borysiuk, P., Jenczyk-Tolloczko, I., Auriga, R., Kordzikowski, M. (2019), Sugar beet pulp as raw material for particleboard production. Industrial Crops and Products, 141, 111829.

Bušić, A., Kundas, S., Morzak, G., Belskaya, H., Marđetko, N., Ivančić Šantek, M., Komes, D., Novak, S., Šantek, B. (2018), Recent trends in biodiesel and biogas production. Food Technology and Biotechnology, 56(2), 152-173.

Cieciura-Włoch, W., Borowski, S., Otlewska, A. (2020), Biohydrogen production from fruit and vegetable waste, sugar beet pulp and corn silage via dark fermentation. Renewable Energy, 153, 1226-1237.

Gajraj, R.S., Singh, G.P., Kumar, A. (2018), Third-generation biofuel: Algal biofuels as a sustainable energy source. In: Biofuels: Greenhouse Gas Mitigation and Global Warming. Germany: Springer. p307-325.

Haankuku, C., Epplin, F.M., Kakani, V.G. (2015), Industrial sugar beets to biofuel: Field to fuel production system and cost estimates. Biomass and Bioenergy, 80, 267-277.

Hache, E., Palle, A. (2019), Renewable energy source integration into power networks, research trends and policy implications: A bibliometric and research actors survey analysis. Energy Policy, 124, 23-35.

He, M., Zhang, Y., Gong, L., Zhou, Y., Song, X., Zhu, W., Zhang, M., Zhang, Z. (2019), Bibliometrical analysis of hydrogen storage. International Journal of Hydrogen Energy, 44, 28206-28226.

Hinková, A., Bubník, Z. (2013), Sugar beet as a raw material for bioethanol production. Czech Journal of Food Sciences, 19(6), 224-234.

Jiménez, I.D., Páez-Lerma, J., Soto-Cruz, N.O., Gracida, R.J.N. (2014), Modelling of ethanol production from red beet juice by *Saccharomyces cerevisiae* under thermal and acid stress conditions.

Food Technology and Biotechnology. 52(1), 93-100.

Langeveld, J.W.A., Dixon, J., van Keulen, H., Quist-Wessel, P.M.F. (2013), Analyzing the effect of biofuel expansion on land use in major producing countries: Evidence of increased multiple cropping. Biofuels, Bioproducts and Biorefining, 8(1), 49-58.

Leu, H.J., Wu, C.C., Lin, C.Y. (2012), Technology exploration and forecasting of biofuels and biohydrogen energy from patent analysis. International Journal of Hydrogen Energy, 37(20), 15719-15725.

Li, B., Yang, T., Li, R., Kai, X. (2020), Co-generation of liquid biofuels from lignocellulose by integrated biochemical and hydrothermal liquefaction process. Energy, 200, 117524.

Liao, H., Tang, M., Luo, L., Li, C., Chiclana, F., Zeng, X.J. (2018), A bibliomteric analysis and visualization of medical big data research. Sustainability, 10, 1-18.

Madhania, S., Muharam, Y., Winardi, S., Purwanto, W.W. (2019), Mechanism of molasses-water mixing behavior in bioethanol fermenter. Experiments and CFD modeling. Energy Reports, 5, 454-461.

Mao, G., Huang, N., Chen, L., Wang, H. (2018), Research on biomass energy and environment from the past to the future: A bibliometric analysis. Science of the Total Environment, 635, 1081-1090.

Mao, G., Zou, H., Chen, G., Du, H., Zuo, J. (2015), Past, current and future of biomass energy research: A bibliometric analysis. Renewable and Sustainable Energy Reviews, 52, 1823-1833.

Marzo, C., Díaz, A.B., Caro, I., Blandino, A. (2019), Status and perspectives in bioethanol production from sugar beet. In: Bioethanol Production from Food Crops. United States: Academic Press. p61-79.

Mujtaba, M.A., Cho, H.M., Masjuki, H.H., Kalam, M.A., Ong, H.C., Gul, M., Harith, M.H., Yusoff, M.N.A. (2020), Critical review on sesame seed oil and its methyl ester on cold flow and oxidation stability. Energy Reports, 6, 40-54.

Nicodème, T., Berchem, T., Jacquet, N., Richel, A. (2018), Thermochemical conversion of sugar industry by-products to biofuels. Renewable and Sustainable Energy Reviews, 88, 151-159.

Ochoa, V.G., Álvarez, N.J., Acevedo, C. (2019), Research evolution on renewable energies resources from 2007 to 2017: A comparative study on solar, geothermal, wind and biomass energy. International Journal of Energy Economics and Policy, 9, 242-253.

Ogunkunle, O., Ahmed, N.A. (2019), A review of global current scenario of biodiesel adoption and combustion in vehicular diesel engines.

Energy Reports, 5, 1560-1579.

Omoregbe, O., Mustapha, A.N., Steinberger-Wilckens, R. (2020), Carbon capture technologies for climate change mitigation: A bibliometric analysis of the scientific discourse during 1998-2018. Energy Reports, 6, 1200-1212.

Putrasari, Y., Praptijanto, A., Santoso, W.B., Lim, O. (2016), Resources, policy, and research activities of biofuel in Indonesia: A review. Energy Reports, 2, 237-245.

Roukas, T. (1996), Ethanol production from non-sterilized beet molasses by free and immobilized *Saccharomyces cerevisiae* cells using fed-batch culture. Journal of Food Engineering, 27(1), 87-96.

Singh, A., Sevda, S., Abu Reesh, I., Vanbroekhoven, K., Rathore, D., Pant, D. (2015), Biohydrogen production from lignocellulosic biomass: Technology and Sustainability. Energies, 8(11), 13062-13080.

Srivastava, R.K., Shetti, N.P., Reddy, K.R., Aminabhavi, T.M. (2020), Biofuels, biodiesel and biohydrogen production using bioprocesses. A review. Environmental Chemistry Letters, 18(4), 1049-1072.

Tsay, M.Y., Yang, Y.H. (2005), Bibliometric analysis of the literature of randomized controlled trials. Journal of the Medical Library Association, 93, 450-458.

Valencia, G.E., Duarte, J.E., Obregón, L.G. (2018), Trend analysis of liquid biofuels research during the years 2010 to 2018. International Journal of Applied Engineering Research, 13, 1104-1111.

Weida, S., Kumar, S., Madlener, R. (2016), Financial viability of grid-connected solar PV and wind power systems in Germany. Energy Procedia, 106, 35-45.

Zhai, X., Zhao, J., Wang, Y., Wei, X., Li, G., Yang, Y., Chen, Z., Bai, Y., Wang, Q., Chen, X., Li, M. (2018), Bibliometric analysis of global scientific research on lncRNA: A swiftly expanding trend. Biomed Research International, 2018, 1-8.

Zhou, W., Kou, A., Chen, J., Ding, B. (2018), A retrospective analysis with bibliometric of energy security in 2000-2017. Energy Reports, 4, 724-732.

Ziemiński, K., Kowalska-Wentel, M. (2015), Effect of enzymatic pretreatment on anaerobic co-digestion of sugar beet pulp silage and vinasse. Bioresource Technology, 180, 274-280.

Ziolkowska, J.R. (2020), Biofuels technologies: An overview of feed-stocks, processes, and technologies. In: Biofuels for a More Sustainable Future. Netherlands: Elsevier. p1-19.