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BIODIESEL CONSUMPTION OUTLOOK IN MEXICO

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ABSTRACT

Mexico has a developing biodiesel market. Although the international trend of production and consumption has increased over the last decade, the quantities produced in the country are still minimal compared to those of petrodiesel. To understand the reasons why Mexico has an under-exploited and under-utilized market, this work describes the current demand situation with a theoretical proposal of a model that responds to seven explanatory variables of its behavior: price of biodiesel, price of petrodiesel as a substitute good, price of petrodiesel as a complementary good, income of the population, number of transports with a functional diesel engine, certifications, and the availability of the product in the supply chain. The lack of regulation regarding the norms for the production, handling, transport, and disposal of this type of biofuel means that there is still no defined biodiesel market in Mexico, which means that most biodiesel production is destined for self-consumption or informal retail sales, which means that the product does not have a defined supply chain in the country.

Keywords: certifications, demand, petrodiesel.

INTRODUCTION

Mexico is considered one of the 10 largest oil producers and exporters in the world (PEMEX, 2020). The country's budget revenue from oil in 2019 was 3.9 %, and by 2020 it was 3.5 % of total GDP (SHCP, 2020), representing an important part of the nation's income. However, the National Hydrocarbons Commission mentions that the country has 8.8 years of proven reserves with minimal risk for extraction according to the relationship between reserves and crude oil production, considering 1.6 million barrels per day under current technological conditions. These types of reserves, from a financial perspective, are the most important because they underpin investment projects, as they have a probability of extraction of at least 90 % (CNH, 2021).

Various organizations worldwide have examined the sustainability of the current energy system and hold a general view: "The energy system as we know it is

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unsustainable." The energy model is conditioned by three factors: 1) the availability of resources to meet the demand for energy; 2) the environmental impact caused by the means used for its supply and consumption; and 3) the lack of equity in access to this essential element for human development (Castro-Martínez *et al*., 2012). These factors call for the use of bioenergy and renewable energies that have a low environmental impact, contribute to climate change mitigation, and reduce dependence on fossil fuels (Montero-Alpírez *et al*., 2016).

Bioenergy use falls into two main categories: traditional and modern. Traditional use refers to the combustion of biomass in forms such as wood for fuelwood, animal waste, and traditional charcoal. Modern bioenergy technologies include liquid biofuels produced from different plant species and oils, biorefineries, biogas produced by anaerobic digestion of waste, and heating systems using wood pellets, among other technologies. At present, two types of liquid biofuels can be distinguished: bioethanol and biodiesel. Modern bioenergy accounted for approximately 5.1 % of total global energy demand in 2018 (REN21, 2020).

Biofuels are an attractive source of energy because they are produced from renewable feedstock sources. They are also biodegradable, non-toxic, and generate fewer undesirable emissions (CO, aromatic hydrocarbons, soot particles, metals, sulfur, and nitrogen oxides). They are produced in liquid form and are mainly used for the transport sector as substitutes for gasoline and diesel, either in full or in blends (OECD, 2018). The production and use of renewable energy have led to an increase in the use of labor, generating a total of 12 018 041 jobs worldwide in 2020, of which 2 410 862 were created by production activities related to liquid biofuels (IRENA, 2022).

This essay takes a critical approach to analyzing the current state of the biodiesel market in Mexico, which was found to be incipient compared to the fossil diesel market. A theoretical model of biodiesel demand was proposed, documented by the behavior of the components that could explain the consumption of this biofuel, with the aim of determining the variables that have an impact on the consumer and thus encouraging the development of this market and understanding the challenges and opportunities of optimizing its use and consumption.

BIODIESEL AS A PRODUCT

Over the past decade, according to data from the International Renewable Energy Agency, there has been an increasing trend in energy capacity from bioenergy (Table 1). This can be classified into four categories: solid biofuels, comprising solid organic non-fossil material of biological origin (also known as biomass) such as charcoal, wood, wood residues and by-products, black liquor, bagasse, animal waste, vegetable waste, and the renewable fraction of industrial waste; biogas, consisting mainly of methane and carbon dioxide, produced by anaerobic digestion of biomass or by thermal processes from biomass, including that contained in waste; municipal waste; and liquid biofuels such as ethanol or biodiesel (IRENA, 2022).

Table 1. Global comparison of bioenergy categories produced (MW).

Year	2010	2020
Solid biofuels	47 788	89 042
Biogas	9519	20 108
Municipal renewable waste	6677	15 414
Liquid biofuels	1869	2637
TOTAL	65 853	127 201

The American Society for Testing and Materials defines biodiesel as a mixture of mono-alkyl esters of long-chain fatty acids obtained from vegetable oils or animal fats used in compression ignition engines (ASTM, 2021). This fuel is an alternative to petroleum diesel and is obtained from biomass, making it renewable. Depending on the raw material source, it is classified as first, second, or third generation. First generation biodiesel is defined as biodiesel produced from the processing of oils extracted from food crops, such as soybean, sunflower, and canola oils. Second-generation feedstocks come from non-food-competing crops or from animal and plant residues such as *Jatropha curcas* L., *Ricinus communis* L., yellow fats, animal tallow, and waste vegetable oils. Lastly, third-generation microalgae are produced from microalgae (Montero-Alpírez *et al*., 2016).

In Mexico, the Ministry of Agriculture and Rural Development (SADER) is in charge of granting prior permits for the production of first-generation biodiesel from maize grain in its various forms, which are granted only when there are surplus inventories of domestic maize production to satisfy national consumption. The production of second-generation bioenergy does not require a prior permit (DOF, 2008).

Biodiesel is commercially produced by transesterifying vegetable oils with alcohol. The most commonly used alcohols are methanol and ethanol, which can be produced from renewable energy sources. In this reaction, vegetable oils or animal fats react with an alcohol in the presence of a catalyst (acidic, basic, or enzymatic), producing the corresponding alkyl esters of alcohol and glycerol (Castellar-Ortega *et al*., 2014). As a liquid biofuel, biodiesel is part of a cleaner transition to a mobility paradigm based on internal combustion. While providing environmentally more sustainable mobility alternatives to fossil fuels, biodiesel enables cleaner mobility without major technical changes (Torroba, 2020).

Regarding the energy efficiency of pure biodiesel (100 %), which is known as B100, Balan-Chan (2018) reported a reduction of 9 mg kg kg^{-1} sulfur over fossil diesel fuel, a reduction of 0.02 kg MJ^{-1} carbon dioxide (CO_2), 0 % m/m paraffin content, and 11 % m/m oxygen content, which makes it have a cleaner combustion process. However, it should also be noted that their combustion can lead to an increase in nitrogen oxides (NO_x) by 10 % compared to fossil diesel.

BIODIESEL PRODUCTION IN MEXICO AND THE WORLD

Biodiesel production and consumption are relatively recent. For example, for the United States, the second largest biodiesel producer in 2020 and the main foreign supplier of biodiesel to Mexico, its production in 2000 was zero (EIA, 2021); however, at the international level, there has been an increasing production trend in recent years (Table 2).

Table 2. Global biofuel production (thousands of barrels per day).

	2015	2016	2017	2018	2019
Production	2218	2324	2393	2612	2690
Bioethanol	1685	1703	1731	1850	1886
Biodiesel	533	621	662	762	805

Globally, in 2019, bioethanol accounted for around 59 % of biofuel production (in terms of energy). Fatty acid methyl ester (FAME) biodiesel accounted for 35 % and hydro-biodiesel (HVO hydrotreated vegetable oil) for 6 % (REN21, 2020).
Biodiesel production is geographically diverse. In 2021, in order of production importance, are the European Union, Indonesia, Brazil, the USA, Argentina, China, Thailand, Malaysia, Colombia, and Canada (Table 3) (Statista, 2023).

Table 3. Main biodiesel producing countries in 2021.

Location	Country	Biodiesel (Mg)
1	European Union	9.92
2	Indonesia	8.2
3	Brazil	5.95
4	United States	5.46
5	Argentina	1.72
6	China	1.5
7	Thailand	1.46
8	Malaysia	1
9	Colombia	0.58
10	Canada	0.32

In Mexico, there are no reliable statistics on biodiesel production (Sosa-Rodríguez and Vázquez-Arenas, 2021), despite the fact that the country has a high potential for biodiesel production from non-food crops and plant and animal waste. Riegelhaupt *et al.* (2016) estimated that, in Mexico, the production of oilseeds (palm, coconut, soybean, sunflower, higuerilla, and jatropha) specifically for the production of oils for biodiesel could evolve from 295 019 oil-equivalent m^3 in 2014 to 607 223 oil-equivalent m^3 in 2030.

However, production is still incipient (Montero-Alpírez *et al*., 2016), and the quantities produced and marketed are not comparable to those of fossil fuels (Paredes-Cervantes *et al*., 2020). This is reflected in the energy consumption of petroleum diesel, which in 2020 in Mexico was 627 880 PJ, while the total energy consumption of all renewable energies for the same year in the country was 387 170 PJ (SENER, 2021). In 2020, Mexico bought 2240 Mg of biodiesel from the United States, its main supplier. These imports contribute to the product being marketed in the country (Table 4).

Table 4. US biodiesel exports to Mexico.

Year	Mg	Participation (%)
2017	20440	6.96
2018	12180	3.9
2019	3920	1.13
2020	2240	0.59

As for the legal framework underpinning the production of biodiesel in the country as a bioenergy, we find the Law for the Promotion and Development of Bioenergy (LPDB), which regulates articles 27 and 27 Section XX of the Political Constitution of the United Mexican States, with the purpose of planning the development of activities in this area.

BIODIESEL DEMAND

In order to understand the consumption behavior of a product, it is necessary to study how its demand behaves, which refers to the complete relationship between the price of a good and the quantity demanded of it. Many factors influence purchasing plans for biodiesel or any satisfactory biodiesel. For example, the quantity of a satisfier that a person wants to buy in a given period is a function of the price of the satisfier, or the person's monetary income, the price of other satisfiers, and the person's tastes (Salvatore, 1977).

The behavior of biodiesel demand could be explained by a theoretical model composed of the following variables:

QBD as a function of (*PBD*, *PPDS*, *PPDC*, *IP*, *QTR*, *CER*, *DIS*)

where *QBD* is the quantity demand for biodiesel (product), *PBD* is the price of biodiesel (good price), *PPDS* is the price of petrodiesel (substitute good price), *PPDC* is the price of petrodiesel (complementary good price), *IP* is the income of the population (income received by the population), *QTR* is the number of transports that have a functional diesel engine (population), *CER* is the certifications (market variable), and *DIS* is the availability in the supply chain (market variable).

Biodiesel price

The first determining factor is the relationship between the quantity of biodiesel demanded and its price. Biodiesel prices depend mainly on the costs of the raw materials used for its production, with this price being approximately 76 % of the biodiesel production costs (Almeida-Naranjo *et al*., 2022). This cost is attributed to a feedstock with a different environmental profile, which makes decision-making at the operational level crucial to reducing production costs and managing the environmental performance of biodiesel while maintaining the quality and parameters set by regulatory institutions. In this regard, Sandar *et al*. (2019) mentioned that the low probability of a successful introduction of liquid biofuels is due to high production costs, which would lead to high prices, and therefore biofuel would not be consumed in high quantities according to the law of demand.

Bioenergy competes in an open market field against traditional fossil fuels that are still abundant and cheap, as their environmental costs are not internalized. This means that bioenergy prices are often not competitive with fossil fuel prices (Sosa-Rodríguez and Vázquez-Arenas, 2021). The cost of biodiesel is 10 to 50 % higher than that of petroleum diesel. Although biodiesel has many advantages over petrodiesel, high production prices are a barrier to its commercialization. Opportunities for biodiesel are small, mainly due to insufficient feedstock production that requires a fiscal incentive policy to keep producers in the market (Paredes-Cervantes *et al*., 2020). Improving production processes and lowering processing costs may represent an area of opportunity.

In Mexico, there are two sources for producing biodiesel: a) crude vegetable oils; and b) used oils and fats. Of the former, 38 % of biodiesel was produced in 2016 from seeds such as Mexican piñón (*Jatrophacurcas*) and higuerilla (*Ricinus communis*) (Riegelhaupt *et al*., 2016). Mexico has potential areas for the production of crops that will supply biorefineries or biofuel production centers. However, it requires the establishment of legislation to maintain the price of inputs, as well as production guidelines to consolidate supply chains that allow for sustainable and economically viable development (Rosas-Barajas *et al*., 2017).

The second method, using low-cost, non-edible oils, could be an option to enhance the competitiveness of biodiesel production and commercial production on an industrial scale (Salvi and Panwar, 2012). Biodiesel will be a sustainable alternative when the challenge of a cost-effective source of supply is overcome (Rosas-Barajas *et al*., 2017). The use of low-cost feedstocks, such as used cooking oils, has gained importance in biodiesel production due to its potential economic and environmental advantages (Caldeira *et al*., 2014). The use of waste oils as feedstock can consider two options that exist in practice in Mexico: 1) the company pays a set price for used oil through independent collectors; and 2) the company collects the used oil and pays a price at source (Riegelhaupt *et al*., 2016).

In Mexico, it was reported that a liter of used oil at the factory gate is paid between 7 and 8 MXN L^{-1} and that the conversion ratio of oil to biodiesel is 1:1 (by volume). Oil is the largest component (55 %) of the production cost of biodiesel from waste oils, which is estimated at 13.72 MXN L^{-1}, and the price of biodiesel ranges between 14.22 and 18.22 MXN L^{-1} (Riegelhaupt *et al*., 2016). However, it is difficult to define an average price for biodiesel due to the structure of the market, which is mostly informal or self-consumption. Sosa-Rodríguez and Vázquez-Arenas (2021) indicated a biodiesel price in the range of 0.53 to 0.87 USD L^{-1}, which in national currency is equivalent to 9.13 to 14.99 MXN L^{-1}. However, Mexico does not have sufficient infrastructure to transform the amount of waste oil required to supply the national demand for biofuels (Rosas-Barajas *et al*., 2017).

In Mexico City, the Ministry of the Environment (SEDEMA) is in charge of promoting the proper management of the final disposal of cooking oil. In 2015, the environmental standard NADF-012-AMBT-2015 was created to establish the technical specifications for the integrated management of waste animal and/or vegetable fats and oils in the city and thus facilitate their use and recovery in order to reincorporate them into production processes such as obtaining biodiesel. According to SEDEMA (2017), there are only 10 registered companies dedicated to the collection and storage of cooking oil. According to Riegelhaupt *et al.* (2016), the companies involved in collecting cooking oil for biodiesel production in various parts of the country are: Reoil Mexico, Moreco, Biofuels of Mexico, and Solben (two of them with activities in Mexico City).

Likewise, documentation is needed on pre-treatment methods by type of oil or fat to optimize their use, as their cost varies depending on the raw material and the technology used without being able to contribute to an overall cost that is attractive to bidders, in addition to not including logistics and operating costs, which are also a barrier for those who want to participate in the supply of biodiesel, as they are high.

On the other hand, some private sector companies recycle the oil used in their production processes to produce biodiesel, as it is cheaper than final disposal and is considered wasteful in Mexico. The biodiesel generated by these companies is used for self-consumption as an additive to the fuel used in their transport fleet, seeking recognition as socially responsible companies. For this reason, one of the main challenges for biodiesel production in Mexico is related to its input and transport costs, restricting its pre-production and consumption locally (Sosa-Rodríguez and Vázquez-Arenas, 2021).

Price of the substitute good

Biodiesel obtained from vegetable oils is an alternative to replace part of the oil demanded, proving to be a good fuel when blended in any proportion with diesel from fossil fuels (Mofijur *et al*., 2016). In this scenario, it was considered that the best substitute for biodiesel is fossil diesel, and vice versa. The most obvious benefits of using biodiesel as a complement or substitute for fossil diesel is that it is a biodegradable, non-explosive, non-flammable, renewable, and non-toxic substance whose combustion generates low levels of greenhouse gas emissions such as CO_2, NO_x, SO_x, and particulate matter (Mofijur *et al*., 2016). For biodiesel to become a real energy alternative, it is necessary that this product not only has equivalent characteristics to fossil diesel, but also that positive greenhouse gas emission balances are achieved throughout the production process and that it reaches the market at a lower or similar price to petroleum diesel (Medina-Ramírez *et al.,* 2012).

The fossil energy balance represents the ratio between the energy contained in the biofuel and the fossil energy used in its production. A fossil energy balance of 1.0 means that it takes as much energy to produce one liter of biofuel as there is energy in the biofuel; in other words, the biofuel in question is neither a net energy gain nor a net energy loss. An energy balance of 2.0 means that one liter of biofuel contains twice the energy needed to produce it (FAO, 2008). For biodiesel produced from waste vegetable oil, the energy balance is between 4.8 and 5.8 energy units, and for diesel, it is slightly less than 1 energy unit (FAO, 2008).

Price of the complementary good

Normally, biodiesel is blended with fossil diesel, with the B20 blend (20 % biodiesel and 80 % fossil diesel) being the most common in Mexico. Some countries have used blends with higher proportions, such as B30 (30 % biodiesel and 70 % fossil diesel) and the pure form B100, because the percentage of biodiesel that can be used varies by engine year and manufacture (IMP, 2017). In this case, diesel can also be considered a complementary good. The benefits inside combustion engines are notable, as they can extend engine life, aid fuel efficiency, and reduce greenhouse gas emissions (Ogunkunle and Ahmed, 2019).

In Mexico, in order to use biofuels within the national territory in the automotive and aeronautical sectors, they must be blended with fossil fuels in terms of NOM-016-CRE. However, when the standard was studied, it was found that there is no technical specification for the blending of biodiesel, and those mentioned for biofuels refer specifically to bioethanol. High production costs restrict the profitability of this fuel, as the selling price of biodiesel depends on the price of fossil fuels. Therefore, in order to create a market, it is essential that the price of biodiesel becomes independent of non-renewable fuels (Sosa-Rodríguez and Vázquez-Arenas, 2021).

Income of the population

Consumer income also influences demand. Although an increase in income leads to an increase in demand for most goods, this demand does not extend to all goods. A normal good is one for which demand increases as income rises; an inferior good is one for which demand falls as income rises (Salvatore, 1977). In this work, biodiesel was considered to belong to the classification of an inferior good because of the hypothesis that suggests that, if the income of the population increases, they will no longer be forced to use the diesel substitute, so they will be indifferent to purchasing one or the other depending on their prices. For practicality, the consumer will be inclined to use petroleum diesel as biodiesel does not have a defined supply chain within the national territory (Rosas-Barajas *et al*., 2017).

Number of transports with a functional diesel engine

In recent years, biodiesel production in the international context has increased as a result of efforts to mitigate climate change and promote sustainable development (Montero-Alpírez *et al.*, 2016). The global adoption of biodiesel in the transport sector has brought with it a reliable fuel supply that can be used in diesel-type engines without modification (Ogunkunle and Ahmed, 2019).

By 2020, 1 411 242 trucks and cargo vans were registered in circulation in the State of Mexico and 57 046 passenger trucks were using diesel, figures that increased compared to those registered in 2010, which were 560 346 trucks and cargo vans and 10 909 passenger trucks (INEGI, 2020), with these types of transport being the main potential consumers of biodiesel. By increasing its presence, biodiesel consumption could also increase its demand.

Certifications

The properties of biodiesel are highly dependent on the type of feedstock used for its production (Zhang and Jiang, 2017). Therefore, fuel specifications are necessary to confine fuel properties to an acceptable range, control fuel quality, and ensure reliable performance in engine use, as the rational consumer will always be looking for the best possible quality. One of the main technical challenges involved in biodiesel production in Mexico is the fact that low-quality feedstocks are used, mainly waste and used oils, which have a high percentage of free fatty acids that hinder the alkaline transesterification process (Sosa-Rodríguez and Vázquez-Arenas, 2021).

Quality assurance of biodiesel through technical specifications is not only functional to ensure the physico-chemical characteristics of the biofuel but also influences consumer confidence and, in turn, the successful marketing of the product, so its implementation is essential to stimulate the market. Sandar *et al*. (2019) noted that global quality standardization would enhance the potential of this product by making it a commodity.

Among the existing worldwide specifications for biodiesel, those of the American Society for Testing and Materials (ASTM) and the European Committee for Standardization (CEN) stand out, particularly ASTM D6751 and UNE EN14214, which define the quality of pure biodiesel, while ASTM D7467 and EN590 explain biodiesel blends. The properties listed in these specifications include calorific value, cetane number, density, viscosity, ash content, copper corrosion, water content, sulfur, and glycerin, among others (ASTM, 2021). In the United States and Canada, the National Biodiesel Accreditation Commission, through the BQ-9000 standard, regulates the characteristics of biodiesel.

Mexico is recognized as an oil-producing and exporting country, so little attention has been paid to energy policy to develop alternative sources, including biofuels. Thus, the Mexican government lacks mandates for specific biodiesel production targets (blending obligations), unlike countries such as Brazil and the European Union (Sosa-Rodríguez and Vázquez-Arenas, 2021). There is a need to create a standardized method to determine the quality parameters included in the Mexican standards for the production and marketing of biofuels, as there is currently no such regulation, which prevents the production of quality biodiesel and continues to encourage the self-consumption market (SENER, 2017).

Supply chain availability

In Mexico, there is little information for the identification of biofuel supply chains, which is insufficient to build indicators of the links of a real supply chain and to initiate a standardization and optimization of production processes (Rosas-Barajas *et al*., 2018). Yue *et al.* (2014) proposed five key components of the biofuel value chain, which are: biomass production system, biomass logistics system, biofuel production system, distribution system, and biofuel end use.

The biodiesel industry in Mexico is incipient and slow-growing, as it is mostly composed of small-scale production for self-consumption (Riegelhaupt *et al.*, 2016). Most of the distribution is done using demijohns or containers (Sosa-Rodríguez y Vázquez-Arenas, 2021). Currently, there are 29 Mexican companies that are part of the supply chain and received permits in a period between December 2009 and April 2018 to carry out activities authorized by the Ministry of Energy for the marketing and transportation of biodiesel. In that period, only one permit was issued for its production (SENER, 2018).

Cabrera-Munguia *et al*. (2022) mention that there are seven companies leading the biodiesel production chain (production, collection, and technology generation), which together generate around 5277 m^3 per year. These companies are: 1) Probioram S. de R.L. de M. I, located in the state of Puebla, which started operations in 2013 and uses animal fat as raw material for the production of biodiesel; 2) RicinoMex, inaugurated in 2017 in the state of Oaxaca as an initiative to build a bio-refinery, managing the link with farmers in the region for the planting of fig trees and the production of biodiesel and castor oil; 3) Cooperativa Agrícola Luz Michell S.C. de R.L. de C.V., located in the state of Durango, is one of the largest biodiesel producers in Mexico, which started operations in 2015 and uses animal fats and cottonseed oil as feedstock; 4) CEDA, which started operations in 2020 in the Central de Abastos in the Iztapalapa mayoralty of Mexico City, with support from the city government through the Ministry of Education, Science, Technology, and Innovation (SECTEI) and the National Polytechnic Institute (IPN), and has a large production capacity plant that converts waste edible oil into biodiesel; 5) Enrimex, located in the north of the state of Baja California, has been producing biodiesel since 2014, using fig seed oil as a raw material; 6) Grima Biodiésel, a company that started operating in 2010 in the state of Puebla that also offers advice, technical support, training, consultancy, and certified equipment for bioenergy projects focused on the use of biofuels; and 7) Biorecen, established in 2011 in the state of Mexico, produces biodiesel and is dedicated to the collection, management, and final disposal of all types of waste.

In terms of research, the Ministry of Energy, together with the National Council of

Humanities, Sciences and Technologies (CONAHCYT), established the Sectoral Fund for Energy Sustainability (FSE), whose purpose is to finance initiatives and programs to promote the design and implementation of projects for the sustainable use of various renewable energy sources. The ESF was created in 2008 and financed the Mexican Energy Innovation Centres (CEMIEs), which are groupings of public or private research centers, higher education institutions, companies and governmental entities that aim to work together on projects dedicated to developing technologies, products and services that allow the country to take advantage of its potential in the main renewable energies. Within CEMIEs, research is considered for solid biofuels, bio-alcohols, biodiesel, biogas and bioturbosine (CONAHCYT, 2016). The "advanced biodiesel cluster", located in the city of Guadalajara, is intended for the scientific and technological development of biodiesel. Currently, it is not operating due to the cancellation of the government budget in 2021 (Advanced Biodiesel Cluster, 2016).

In general, information on marketing channels, customers, and prices is scarce and unreliable, making it difficult to describe a formal biodiesel market (Riegelhaupt *et al*., 2016). Sosa-Rodríguez and Vázquez-Arenas (2021) found that there are currently no service stations or infrastructure for the distribution of biodiesel, as is the case for hydrocarbons (pipelines), nor security for transport guidelines. This makes it difficult for consumers to access the product, and the way in which it is distributed, without a regulatory framework, as it is marketed in cylinders, leads to a lack of confidence in biodiesel purchases. Therefore, there is a need for rules that not only regulate production standards, but also take care of the technical requirements for the distribution of biofuel.

CONCLUSIONS

International demand for biodiesel has increased; however, in countries such as Mexico, the market is still incipient compared to that of petrodiesel, as its low production is destined for self-consumption or informal sales. According to the structure of biodiesel demand analyzed, petroleum diesel is its main substitute and, at the same time, its main complementary good, as both are used simultaneously, with the B20 blend being the most common for Mexico. It was determined that for there to be an increase in the amount of biodiesel consumed, its price needs to be lower than that of petrodiesel, with the use of recycled feedstock from used cooking oil being an option to reduce its production cMexico lacks official figures on biodiesel consumption. Several studies pointed out that tastes and preferences for their use are growing for reasons of contributing to climate change mitigation. Furthermore, the consumption of this biofuel is growing with the increasing presence of functional biodiesel engines. Likewise, it was detected that the necessary certifications to regulate the consumption of biodiesel and thus ensure consumer confidence through quality standards do not exist. Finally, this essay analyzed the need for standards to regulate the biodiesel market production chain, from raw material collection and handling to control at points of sale to facilitate its distribution and supply in the national territory. Despite Mexico's potential for the production of alternative fuels and the benefits they represent, there is no clarity regarding their future development. To achieve this, the intervention of federal agencies is necessary to promote biofuel production based on a well-defined national development plan.

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