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Milestone Study on Post-Consumption Bioplastics Waste Management and Secondary Markets in Mexico

Transforming Recycling and Solid Waste Management in Mexico

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Commission for Environmental Cooperation
1001 Robert-Bourassa Boulevard, suite 1620
Montreal, Quebec, Canada, H3B 4L4
Tel.: 514.350.4300; fax: 438.701.1434
info@cec.org / www.cec.org

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Acronyms and Abbreviations

AMB	*Asociación Mexicana de Bioplásticos*, A.C. (Mexican Association of Bioplastics)
ANIPAC	*Asociación Nacional de Industrias del Plástico*, A.C. (National Association of Plastics Industries)
Bio-PE	bio-polyethylene
Bio-PET	bio–polyethylene terephthalate
Bio-PP	bio-polypropylene
Bio-PVC	bio–polyvinyl chloride
CEC	Commission for Environmental Cooperation
CIQA	*Centro de Investigación en Química Aplicada* (Applied Chemistry Research Center [Saltillo, Coahuila])
CSi	final controlled disposal site
EEA	European Environment Agency
EUBP	European Bioplastics
FDS	final disposal site for municipal solid waste or special-handling waste
HDPE	high-density polyethylene
INECC	*Instituto Nacional de Ecología y Cambio Climático* (National Institute of Ecology and Climate Change)
INEGI	*Instituto Nacional de Estadística y Geografía* (National Institute of Statistics and Geography)
ITESM	*Instituto Tecnológico y de Estudios Superiores de Monterrey* (Monterrey Institute of Technology and Higher Education)
kt	kiloton(s)
LCA	life-cycle analysis
LDPE	low-density polyethylene
LDPE/LLDPE	low-density polyethylene / linear low-density polyethylene
LGPGIR	*Ley General para la Prevención y Gestión Integral de Residuos* (Law for the Prevention and Integral Management of Waste)
MRF	materials recovery facility
MSW	municipal solid waste
NIR	near-infrared spectroscopy
PA	biopolyamide
PBAT	polybutylene adipate terephthalate
PBS	polybutylene succinate

PCL	polycaprolactone
PE	polyethylene
PEF	polyethylene furan-2,5-dicarboxylate
PET	polyethylene terephthalate
PHAs	polyhydroxyalkanoates
PHBV	polyhydroxybutylvalerate
PLA	polylactic acid
PP	polypropylene
Profepa	*Procuraduría Federal de Protección al Ambiente* (Office of the Federal Attorney General for Environmental Protection)
PS	polystyrene
PVA	polyvinyl alcohol
Sedema	*Secretaría del Medio Ambiente, Ciudad de México* (Secretariat of the Environment, Mexico City)
Semarnat	*Secretaría de Medio Ambiente y Recursos Naturales* (Ministry of Environment and Natural Resources)
SHW	special-handling waste
SLF	sanitary landfill
SUP	single-use plastic
UAEH	*Universidad Autónoma del Estado de Hidalgo* (Autonomous University of the State of Hidalgo)
UCSi	uncontrolled disposal site (or dump, garbage dump, open dump, landfill, etc.)
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UPAEP	*Universidad Popular Autónoma del Estado de Puebla* (People's Autonomous University of the State of Puebla)

Summary

As part of the Transforming Recycling and Solid Waste Management in North America project of its Operational Plan 2021, the Commission for Environmental Cooperation (CEC) commissioned studies on the recycling and management of paper and cardboard waste, plastics waste, and bioplastics waste, in Canada, the United States and Mexico. The objective of these studies is to accelerate the adoption of circular-economy (CE) practices that would promote strategies for the sustainable management of these materials and generate economic and environmental benefits for the region.

This study focuses on bioplastics waste in Mexico (paper and plastic waste management are presented in separate studies). It follows the recent publication of the similar series focusing on Canada and the United States together.[1] In addition to complementing the previous studies, it provides relevant information for decision-makers on the current state of post-consumption bioplastics waste recycling in Mexico.

This study describes the value chain, the standing infrastructure, the waste management sector and the primary and secondary markets in Mexico, with the aim of providing an overview of the state of recovery and recycling practices for these materials, as employed by the population in the country. It includes a summary of the public policies and regulations applicable within the framework of the circular economy. As well, it identifies best practices in waste management that could be implemented based on the recommendations and findings of this report.

Differences in waste management strategies determine recycling efficiency both among Mexico's states and in comparison with other countries. Notably, because Mexico does not follow the same solid-waste management methods as Canada and the United States, there are significant contrasts in the recovery and recycling of post-consumption waste.

In general, unlike in Canada and the United States, waste collection in Mexico is not subject to fees. Moreover, the budget allocated to infrastructure and public services for waste management creates an important operational difference between the countries.

Meanwhile, the global bioplastics market has shown accelerated growth in the last decade. In 2023, global production capacity was estimated at 2,019 kilotons (kt), 1,011 kt of which corresponded to biodegradable bio-based bioplastics, and 1,008 kt to non-biodegradable bio-based bioplastics. World production was estimated at 1,373 kt, equivalent to 68 percent of installed capacity that year (EUBP 2024). The value of the global bioplastics market, according to various sources, is between US$2.482 billion and US$7.060 billion.

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[1] See Commission for Environmental Cooperation, at: <https://www.cec.org/transforming-recycling-and-solid-waste-management-in-north-america/>.

In Mexico, the production of bioplastics is nascent and is mainly carried out by small, recently created companies, with installed capacities of less than 100 tons per month. Most of them use agro-industrial waste or crops specifically intended for this purpose as raw material. Given the low volume of domestic production, this study considered that apparent consumption corresponds to net imports of resins and finished products. This apparent consumption was also considered to be equivalent to the generation of waste.

Based on these assumptions, it is estimated that in Mexico, in 2022, 1.23 kt of polylactic acid (PLA), 39.42 kt of polyhydroxyalkanoates (PHAs), 103.95 kt of polybutylene succinate (PBS), polybutylene adipate terephthalate (PAT) and polycaprolactone (PCL), and 33.69 kt of finished products made from bioplastics were consumed, with an estimated market value of US$769million. Based on these estimates, waste generation was calculated at 178.29 kt, of which 165.45 kt are not recyclable, 14.27 kt are stockpiled and 12.48 kt are used in recycling plants. Finally, the average growth rates of apparent consumption of bioplastic resins over the last ten years were estimated. The resin with the highest growth in the period is PLA (35.61 percent), followed by PHA (11.34 percent), and PBS, PBAT and PCL (5.16 percent).

In Mexico, the recovery of post-consumption waste made from bioplastics is low: due to its resemblance to single-use plastic, this material is recovered mixed with conventional plastics and sent to final disposal sites, despite having labeling which specifies that it is compostable and biodegradable. Although few measures have been implemented for separate recovery and composting, the construction and operation of more industrial composting plants in the country is required, given the increase in the use of bioplastics, if this material is to be promoted and incorporated into the circular economy.

Generally, the regulation of bioplastics is found in the laws and regulations for plastics, although it could also be incorporated in the regulatory provisions related to municipal solid or special-handling waste. However, the legal framework applicable to bioplastics must be updated in order to fully incorporate in a differentiated manner the materials that are the subject of this report.

The legislation promotes the sending of bioplastic materials for composting, and in the case of bags, their use is promoted for the containment of organic waste and their disposal through local cleaning systems. However, the people or entities able to recover these materials show little interest in it due to its low economic value. A large number of units must be collected to acquire a kilo of material. In addition, the price paid is unattractive. In Mexico, the legal-administrative structure and its application at the local level determine the efficiency of plans and strategies to promote recycling.

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1. Introduction

Every year, more waste is produced globally—thanks to economic growth and unsustainable consumption and production patterns. Between 2020 and 2050, the generation of municipal solid waste per year will increase from 2.1 to 3.8 billion tons, according to estimates in *2024 Global Waste Management Outlook*, published by the United Nations Environment Programme (UNEP). Of this amount, uncontrolled waste, or waste sent to a final disposal site, would increase from 1.45 to 3.66 billion tons, which represents a growth of more than 1.5 times.

In Mexico, between 0.8 and 1.1 kilograms (kg) per capita of waste is generated (Semarnat 2020). However, unlike in Canada and the United States, where waste is properly managed, there are inadequate practices in Mexico due to a lack of infrastructure and, in some cases, insufficient technical capacity of the personnel in charge of collection, handling, treatment and final disposal systems. In short, all these factors result in serious environmental problems—methane emissions into the atmosphere, the presence of undesirable fauna, leachate generation—and in a large number of garbage pickers who search the waste in uncontrolled disposal sites for products with some value as a resource for their subsistence.

Public policies in Mexico have gone through numerous schemes, ranging from integrated waste handling and management to the circular economy, including sustainable development, the 3 Rs model (reduce, reuse and recycle), and sustainability in production and consumption. All of these strategies have encouraged the adoption of environmental awareness and education schemes, as well as investment in infrastructure—both in collection vehicles and sanitary landfills and, in some cases, sorting and treatment plants. However, most of the infrastructure so far acquired has reached the end of its useful life or is in poor operating and maintenance conditions. Meanwhile, in most of the municipalities, the population does not pay fees for the recovery, management and use of the waste it generates, and the municipal cleaning system depends on the assigned budget, which generally provides insufficient funds for proper operation.

The transition to a circular economy is based on identifying a linear economic development path for products, mainly made from virgin raw materials, that have low—and in some cases zero—recycling rates. This translates into a market that is limited or aimed at only those materials with a high commercial value for recovery or recycling, such as paper and polyethylene terephthalate (PET), polyethylene (PE) or polypropylene (PP).

Product redesign and materials substitution are strategies that the private sector has adopted with increasing frequency. One example is the incorporation of biodegradable or *bio-based* plastics, which, according to the National Association of Plastics Industries (Anipac), represent only 1.5 percent of the world's annual production of plastics (390 million tons). However, bioplastics production capacity is projected to exceed 6.2 million tons by 2027 (Anipac 2023).

In the last decade, the performance and availability of biodegradable polymers (BDPs) have improved significantly. This progress responds to the growing interest in sustainable development, the need to reduce dependence on non-renewable resources and the transformation of policies and attitudes towards waste management.

2. Information Sources and Assumptions

For the preparation of this study, documentary research was carried out in electronic media, as well as through a working meeting with the Mexican Association of Bioplastics (AMB, A.C.), the National Institute of Ecology and Climate Change (INECC) and other sources of information on the bioplastics market, which provided general information on the situation of this sector in Mexico. These actions were necessary in the absence of a consolidated domestic market and because bioplastics are novel materials in food sector applications such as packaging, bags and films.

Anipac's 2023 Yearbook (Anipac 2023) is one of the main sources of information of national scope.

At the international level, the most relevant references come from European Bioplastics (EUBP) and the European Environment Agency (EEA), whose online platform provides up-to-date information on the international market.

In addition, Mexico's National Institute of Statistics and Geography (INEGI) collects information on imports of raw materials and products made from bioplastics—mainly polylactic acid (PLA) and polybutylene adipate terephthalate (PBAT). These data served as the basis for the Sankey diagram presented in this study (Figure 5).

For the analysis of the value chain (Section 3), the main source of information used was the bioplastics study on Canada and the US prepared for the CEC (CEC 2024), which considered in a general way its different stages.

The information contained in Section 4, Market Overview, is based on data from Global Growth Insights, Data Bridge Market Research, and The Brainy Insights, obtained through general reports and online consultations on the 2024 biodegradable plastics market.

It should be noted that the official information available in Mexico refers, for the most part, to the amount of waste sent to final disposal in sanitary landfills (SLFs), controlled sites (CSi) or uncontrolled sites (UCSi), otherwise known as *dumps*, *garbage dumps*, *open dumps* or, in many cases, *landfills*, among other names. In order to prepare the monthly reports of municipal scope on which the Basic Diagnosis for the Prevention and Integral Management of Waste (Semarnat 2020) is based, it was necessary to apply assumptions, indexes and indicators, given the limited field information available to accurately determine the amount of waste by type of generator. Therefore, more-detailed analyses are mainly based on approximations and estimates.

Finally, international information from European Bioplastics (2024) was consulted. For Mexico, where bioplastics production is very limited, import and export data were obtained from the United Nations Comtrade Database.

3. Value Chain

3.1 What are bioplastics?

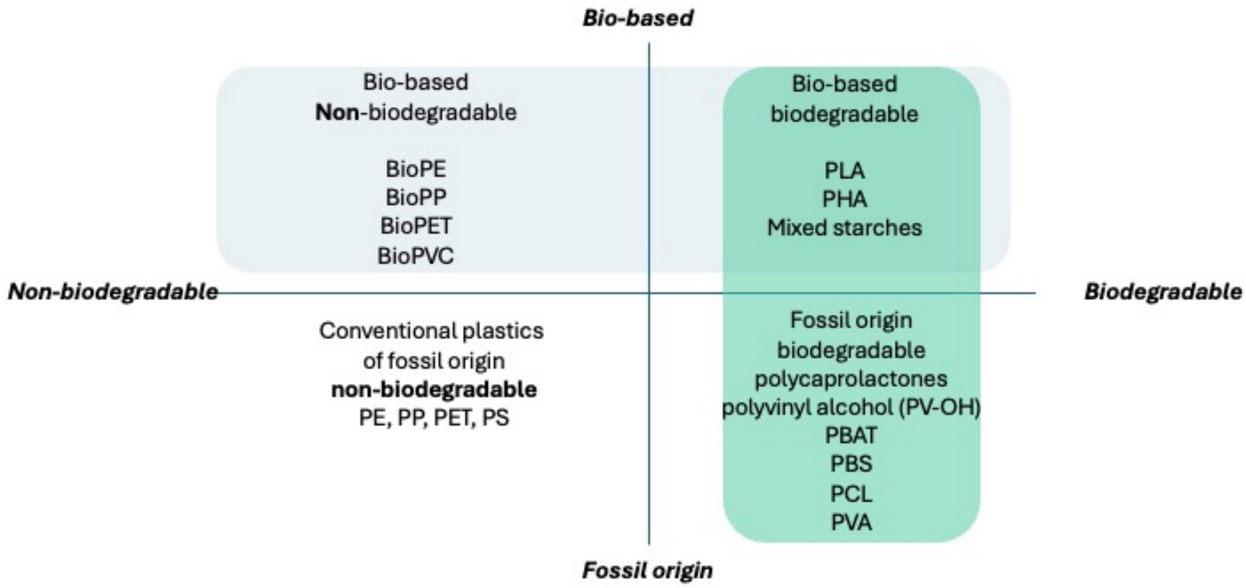
The association European Bioplastics defines *bioplastics* as a broad family of different materials which can be bio-based, biodegradable, or both. *Bio-based plastics* are made from biomass such as plants, algae or microorganisms, and even from waste from these materials. Unlike polymers like rubber, that are of natural origin (*biopolymers*—renewable and biodegradable macromolecules produced by living organisms, such as plants and microorganisms), bio-based plastics must undergo chemical processing to be used and are generally derived from the production of ethanol, lactic acid and other compounds that, when the starch of the plant material is fermented, are transformed into monomers such as lactic acid or PLA, polyethylene, polypropylene, nylon or other plastics with conventional chemical structures and with the same characteristics as those obtained from petroleum. Despite their bio-based origin, these plastics are not necessarily biodegradable—that is, they do not mineralize completely in a given period of time.

There are also biodegradable plastics whose raw material is of fossil or petrochemical origin, designed to mineralize in defined environmental conditions provided by composting processes, marine environments or even anoxic environments, such as in biodigesters, among other means.

Through a process known as *carbon 14 dating*, it is possible to identify the biological origin of a plastic, as this process determines the time elapsed since the source organism of the raw material ceased its carbon exchange with the atmosphere. Thanks to this method it is possible to determine whether the products were made from raw materials or plants harvested in the last ten years, or whether they come from fossil fuels originating from raw materials millions of years old. ASTM D6866-12 (see Table 8 for details) is used to determine the bio-based content of a plastic.

Taking as a starting point the concepts related to the origin of the raw material and the biodegradability characteristics of a product, it is possible to identify four classes of plastics, whose distribution according to the European Environment Agency (EEA) is shown in Figure 1.

Figure 1. Distribution of plastic classes according to the European Environment Agency (EEA)



Source: Prepared by the authors based on data from EEA (2020) and European Bioplastics (2024).

Types of bioplastics and their applications

The classification of bioplastics is based mainly on two criteria: their origin and their decomposability.

Based on their origin, bioplastics can be classified as bio-based or non-bio-based. In the first case, polymers are obtained from plant, animal or bacterial biomass and are therefore renewable resources. Non-bio-based bioplastics are those produced with polymers synthesized from petroleum. In both cases, the products are biodegradable and compostable.

Depending on the degree of decomposition they can attain within a certain time, bioplastics may or may not be biodegradable. Under the right conditions, biodegradable plastics decompose in relatively short periods of time (just a few days to a few months); non-biodegradable plastics, on the other hand, behave like conventional plastics of petrochemical origin; in this case, the decomposition period is measured in decades or even centuries.

By combining both criteria (origin and degree of decomposition), bioplastics can be classified in three groups:

> **Bio-based biodegradable**. Bioplastics that are simultaneously bio-based and biodegradable include polylactic acid (PLA), whose base materials are obtained from corn, cassava, manioc starch, or sugar cane, and which is widely used in the food industry for packaging; and polyhydroxyalkanoates (PHAs). PLA is one of the most widely used bioplastics. It has properties similar to those of polyethylene terephthalate (PET) (a conventional plastic of

the polyester family), although it is less resistant to high temperatures. For their part, PHAs constitute a family of biopolymers whose properties can vary significantly, depending on the specific type of polymer of which they are composed, which makes it possible to adjust their performance to different applications.

Another example of this category is polyhydroxybutylvalerate (PHBV), made from vegetable waste. Obtained from plant cells or by biotechnology from bacterial cultures, these bioplastics are very sensitive to processing conditions and cost up to ten times more than conventional plastics.

Bio-based non-biodegradable. This group includes biopolyethylene (Bio-PE), which has properties similar to those of conventional polyethylene, while Bio-PET has similar characteristics to those of polyethylene terephthalate (PET). Both bioplastics are mostly manufactured from sugar cane, from which bioethanol is obtained as an intermediate product. Biopolyamide (PA), a recyclable bioplastic with excellent thermal insulation properties, also belongs to this category.

Non-bio-based biodegradable. Biodegradability is related to the chemical structure of the polymer and not to the type of raw material used. Therefore, with proper processing, biodegradable plastics can be obtained from petroleum. One example is polycaprolactone (PCL), used in the manufacture of polyurethanes. It is a highly biodegradable bioplastic obtained from petroleum derivatives, as is polybutylene succinate (PBS), and can be found in compostable media. PBS is a biodegradable plastic used for the manufacture of bottles and containers.

The most common bioplastics have diverse properties and applications and may be confused with so-called oxo-degradable plastics. The latter are conventional plastics that, through the addition of additives, have the ability to fragment into smaller particles (pellets), producing only the appearance of biodegradation.

The most frequently used bioplastics in Mexico are the following:

Polylactic acid (PLA)

This is a biodegradable polymer derived from lactic acid made entirely from renewable resources such as corn, beets, wheat and others, all rich in starch.

In addition to being biodegradable, these biopolymers are compostable, transparent and rigid, and behave efficiently as a barrier against oxygen and moisture, which is why they are widely used in the manufacture of food and beverage packaging, films, bags and medical implants, among others.

Polyhydroxyalkanoates (PHAs)

Biodegradable polymers, with high strength and flexibility, and excellent barrier behavior against oxygen and moisture, are obtained, through microbial fermentation, from different substrates, mainly sugars, and lignocellulosic biomass, and can be used as modifiers of other polymers or biopolymers.

Their main applications are as biodegradable materials used in products such as bags, films, surgical materials and electronic components.

Thermoplastic starch

This composite is biodegradable, compostable and low-cost and offers a good barrier against oxygen and moisture. It is a starch modified by the addition of plasticizers (water, glycerin and sorbitol, among others) to enhance its properties. Processed under pressure and heat until the crystalline structure of the starch is completely destroyed and an amorphous thermoplastic starch is formed, this biopolymer is used in the manufacture of food and beverage containers, bags, films, disposable tableware and foams.

Green polyethylene

A bio-based, recyclable polymer that offers high strength and durability, and a good barrier against oxygen and moisture, it is produced from renewable raw materials such as sugar cane or vegetable oil, making it a good substitute for fossil-based polyethylene. Applications include the manufacture of beverage containers, textiles, automotive parts and sporting goods.

Other, new biopolymers

These biopolymers include polybutylene succinate (PBS) and biodegradable furans, with applications in the manufacture of packaging, as well as cellulose-based bioplastics, which are compounds, such as cellulose acetate, derived from cellulose from wood or cotton. They have unique properties and their applications are very specific, but the cost of production is higher. This category also includes algae-based or aliphatic-based bioplastics, the latter produced from the natural bacterial fermentation of sources such as molasses, sucrose, lactose, glycerol, oils and methane (ClimateSort n.d.).

3.2 Value chain summary

Although the products made with them show constant increase, bioplastics as raw materials have a low presence in the market in Mexico. This is attributable to the fact that in this country the manufacture of bioplastic *pellets*—the building blocks of plastic products—is almost nil, mainly restricted to emerging or small companies that venture into their manufacture more as an option for the treatment and use of agro-industrial waste than with the intention of establishing an entire industry for this type of component.

Unlike in the bioplastics value chain in Canada and the United States, in Mexico the entities present in this chain are more focused on importing raw materials for processing into marketed products, such as bags and some disposable products, mostly cups and lids. In the case of other sectors, bioplastics are present in imported finished products.

The bioplastics value chain involves three main sectors:

Raw materials and processing: The most important activity in this sector is the integration of the import of raw materials and the actors. Unlike the conventional plastics industry, the bioplastics industry does not include a significant stage of synthesis of chemical precursors domestically, but rather the selection of imported raw materials for the manufacture of finished products, where the importing parties play a very important role. Similarly, institutions and research centers participate in the development of technology for the manufacture of bioplastics from waste, mainly agro-industrial waste.

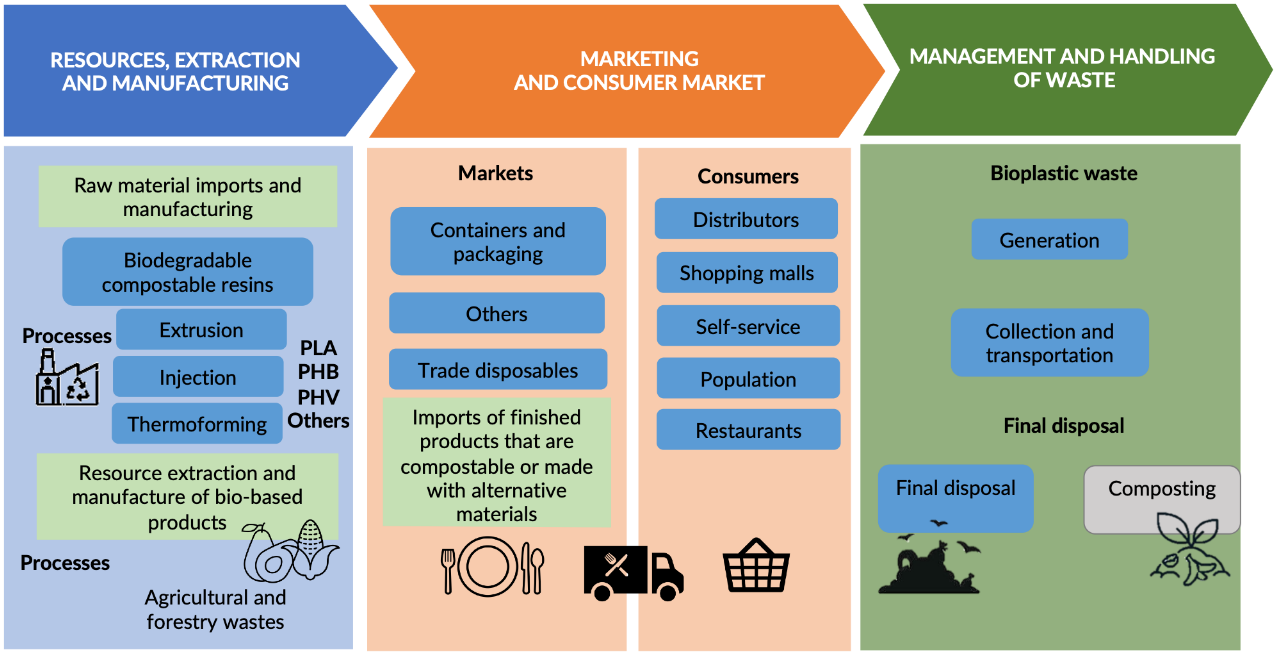
In the processing phase, bioplastics can be used in the same industrial processes as in plastic manufacturing, such as extrusion, injection or thermoforming, for the production of end products.

Consumption: This sector includes bioplastics marketing activities in the different consumer markets, including mainly the packaging and medical markets, as well as applications in the automotive industry, the electrical and electronics sector and the agricultural sector.

Waste management and handling: This sector includes the actors in charge of the recovery, management and, if applicable, use of post-consumption bioplastic waste. Garbage pickers do not play an important role or even figure in the recovery of these wastes, unlike as found in the paper and cardboard and plastics studies, where the participation of these individuals is found to be essential for the recovery of post-consumption waste.

This situation is directly related to the value chain and the life cycle of these materials, since their application in Mexico has increased, although more from imports and the sale of finished products, which has boosted the presence and use of these materials. Therefore, the value chain is still incipient, still with high costs derived from handling and importation, compared to the same products manufactured with traditional plastics.

Figure 2. Bioplastics value chain in Mexico



Source: Prepared by the authors with information from CEC (2024), Anipac (2024) and AMB (2025).

Numerous research projects have been carried out in Mexico by professionals, companies and institutions, with the main objective of solving waste disposal problems through the development of biopolymers.

3.2.1 Raw materials and processing

Mexico, far from being a producer of bioplastics, is a net importer of them, in the form of PLA pellets, PHA, starch, PBAT, PBS and cellulose fiber from sugarcane bagasse or bamboo.

According to the Mexican Bioplastics Association (AMB), the main destinations for the products manufactured from bioplastics are the United States, European countries and emerging markets in Asia. The AMB also notes that there are other types of bioplastics that could be more efficient or of greater value in terms of biodegradability or compostability; however, their availability in Mexico remains limited due to the small size of the domestic market.

The main types of bioplastics imported into Mexico are included in Table 1.

Table 1. Types of bioplastic imported, by country of origin and main applications

Type of bioplastic	Country of origin	Main applications
PLA	Germany, United States, China, The Netherlands	Packaging, filaments, cutlery
PHA	United States, China, South Korea, The Netherlands, Singapore	Compostable, biodegradable utensils
From starch	Corn: United States, Brazil, Turkey, France Potato: Denmark, The Netherlands, Germany, France, United States Wheat: United States	Bags, films, cutlery
PBAT and PBS	China, United States	Optimization of PLA or starch properties
Cellulose (vegetable fibers)	Partially domestic; also imported from the United States, Germany, China, Brazil, Sweden	Biodegradable films and packaging

Source: Prepared by the authors with data from European Bioplastics (2024), Data Bridge Market Research (2024) and Global Growth Insights (2024).

Bio-based bioplastics are made from plant biomass, with the following three basic sources of raw material:

1. Natural biomass polymers

Natural polymers, such as starches or sugars, made from plants can be used. Potato plastic, for example, is a biodegradable bioplastic made from potato starch.

2. Polymers synthesized from biomass monomers

A second alternative is to synthesize polymers from monomers extracted from plant or animal sources. The difference between this route and the previous one is that, in this case, an intermediate chemical synthesis is required. For example, Bio-PE, or green polyethylene, is produced from ethanol obtained from sugar cane.

Bioplastics can also be produced from animal sources, such as glycosaminoglycans (GAGs—eggshell proteins), which gives the advantage of more-resistant bioplastics.

3. Polymers made by biotechnology based on bacterial cultures

The third alternative considers the production of polymers for bioplastics by biotechnology through bacterial cultures, where a large number of bacteria synthesize and store polymers that can be extracted and processed. Mass culture of bacteria requires suitable culture media for further processing and purification. Polyhydroxyalkanoate (PHA), for example, a biodegradable biopolymer used in the manufacture of bags or caps for certain products, is synthesized by various bacterial genera in a medium with excess carbon and lacking nitrogen and phosphorus. An example is polyhydroxybutylvalerate (PHBV), obtained from bacteria fed with sugars derived from plant debris. The major limitation of bioplastics obtained by this process is the cost of production.

These procedures are applied in Mexico, although not for large-scale production but mainly in the field of research, where "laboratory" bioplastics are obtained. The raw material derived from waste is the result of constantly growing research and development projects led by academic institutions such as the *Universidad Nacional Autónoma de México* (UNAM), the *Universidad Autónoma Metropolitana* (UAM), the *Instituto Politécnico Nacional* (IPN), state universities, and research centers, such as the *Universidad Autónoma del Estado de Hidalgo* (UAEH), the *Centro de Investigación en Química Aplicada* (CIQA), the *Instituto Tecnológico de Estudios Superiores de Monterrey* (ITESM) and the *Universidad Popular Autónoma del Estado de Puebla* (UPAEP), among others, whose research in this area includes the extraction of starches and other compounds from agro-industrial waste (see Table 2).

Table 2. Mexican research centers and institutions with activities in the field of bioplastics

Institution	Study area
Cinvestav	Bioplastics
UNAM	Biodegradable plastics from corn and prickly pear cactus
ITESM	Bioplastics PHA from renewable sources
CIQA	PHA from agro-industrial wastes
CIQA, IPN, UNAM	Synthesis of PBS from bio-based succinate obtained from agro-industrial wastes

Source: INECC (2020).

The production of bio-based and biodegradable bioplastics requires natural elements that can be obtained from organic waste of any kind, or produced from crops grown specifically for this purpose. Fossil-based but biodegradable bioplastics can be made by synthesizing biodegradable chemical compounds.

Although Mexico has large areas for the cultivation of raw material used mainly for food or forestry purposes, the use of part of this area for other applications, such as the cultivation of species for the production of materials expressly intended for the production of biopolymers and, therefore, for the manufacture of disposable products, is an issue that raises serious questions, both nationally and internationally, due to the change in land use.

Based on the above, the extraction of organic materials could come from the use of agro-industrial waste capable of providing materials such as starch, cellulose or biomass, in general, including avocado seeds, mango, sugarcane bagasse or even algae, to obtain the chemical bases necessary for the manufacture of bioplastics.

In Mexico, bioplastics production is highly sectorized and concentrated in small or recently created companies, each with installed capacity of less than 100 tons per month. Most of these companies use agro-industrial waste as raw material instead of crops established exclusively for this purpose (see Table 3).

Table 3. Companies that market or produce raw materials for bioplastics in Mexico

Company	Stage	General information
Avani Eco-México	Producer and processor	Subsidiary of Avani Eco-Indonesia, headquartered in Mexico City.
BioSolutions	Producer and processor	Mexican company founded in 2013, dedicated to the production of bioplastic materials from cellulose or agro-industrial biomass, Polyagave brand.
Biofase	Producer, importer and processor	Company dedicated to the production and sale of bioplastic resins or biodegradable plastic from avocado pits. Resins can be processed by injection, extrusion or thermoforming.
Bioelements	Importer and processor	Commercializes and processes compostable PBAT and starch resins.
Ecoplaso	Producer	Produces bioplastics from organic waste, in three formats: sheets, pellets and 3D filaments. Plant processes 300–400 kg per day.
Green Loop	Producer and processor	Based in Querétaro, produces certified biopolymers and compostables.
Green Plastics (GPI Group)	Importer and processor	Imports PBAT to manufacture compostable bags under the Ecosolutions brand.
Xeiba Nutringredients	Producer	Micro-business.
Polybion	Producer	Company in Guanajuato with a solar-powered bio-manufacturing plant with an installed capacity of 1.1 million square feet per year of Celium® biotextile.
Polyone México, DVA Plastics, Resirene	Importer and marketer	PBAT or PLA blends for processing by other companies.
Plastigreen and Green & Compostable Mexico	Importer and marketer	PBAT and PLA resins.
Plastinova	Producer	Linked to the *Instituto Tecnológico de Tepic*, manufactures biocomposites from agave residues and bioplastic matrices.

Company	Stage	General information
Tecnología Regenerativa Mexicana (TRM) (Mexican Regenerative Technology)	Importer and processor	Produces compostable plastics with a mixture of PBAT and starch.

Source: Prepared by the authors with data from INECC (2020).

Major international brands producing resins and biopolymers on a large scale include Braskem Idesa, BASF, Novamont, NatureWorks, Dupont, FKUR Kunststoff GmbH, Arkema France and Corbion. Several of these companies have offices in Mexico.

Table 4 lists the main companies producing resins or bioplastics internationally.

Table 4. Main biopolymer-producing companies, some with commercial representation in Mexico

Company	General information
Braskem	Conventional plastics production plant in Coatzacoalcos, Veracruz. Headquarters in Mexico City, Mexico, for bioplastics imports. Plant in Sao Paulo, Brazil.
NatureWorks	No representation in Mexico. Plant in Minnesota, USA.
Novamont	Commercial representative offices in Mexico. iNovara plant in Italy. Representative in Mexico: Mexibras.
BASF	Commercial offices in Mexico. Plant in Ludwingshafen, Germany.
Corbion	Commercial offices in Mexico. Plants in the US, Amsterdam and The Netherlands.
PSM	Beijing, China
Dupont	Wilmington, Delaware, USA
Arkema France SA	Colombes, Francia
Reyfa	Guangzhou, China
FKUR Kunststoff GmbH	Willich, Germany
Biomero	Krailling, Germany

Source: Prepared by the authors with data from INECC (2020), and Anipac (2023a).

3.2.2 Marketing and consumer market

Restrictions on the marketing of single-use plastics in Mexico, especially in the packaging and packing sector, have prompted the substitution of conventional plastics with materials such as paper, cardboard and bioplastics. This transition has generated diverse results and, in some cases, unforeseen effects, such as impacts on food preservation and transportation. Such substitutions can affect the shelf life of products such as bread and pastries, or cause problems in the shipment of fresh vegetables, such as excess moisture.

The marketing activities for bioplastic products are very similar to those for conventional plastics. The main difference in the case of imports of biodegradable and compostable resins or products is that these operations are carried out by the same producers of conventional plastics or by their representatives and distributors, who introduce them for sale in the Mexican market.

The main consumers include manufacturers of packaging and packing for the food industry and the home delivery sector. Direct consumption in the retail trade is practically non-existent due to the high cost of the final product and the fact that informal businesses opt for traditional disposable products, which are less expensive and easily accessible.

3.2.3 Waste management and handling

Recovery of post-consumption waste made from bioplastics is still very limited. Generally speaking, these materials are collected together with conventional plastics, largely due to their appearance being similar to that of single-use plastics, even though they are marked and labeled as compostable and biodegradable.

The common practice for waste such as PLA-coated paper cups, clamshell containers made from natural fiber, and utensils (spoons, forks and knives) made from bioplastics is to handle them together with mixed waste and send them to final disposal.

However, according to the Mexican Bioplastics Association (AMB), there are efforts for differentiated recovery and large-scale composting at the two recognized composting plants in Mexico City: Bordo Poniente, under the responsibility of the *Secretaría de Obras*, and the biodigestion plant of the *Instituto Politécnico Nacional*, both of which have the capacity to accept bioplastics for processing.

In the case of PLA, this bioplastic is very similar in appearance to conventional PET plastic, but it is not recyclable under the same operating conditions, due to differences in its melting temperatures and fluidity. When both materials are found mixed in the same recycling container, the contents of the container cannot be recycled without a prior process of separation by type of material or without adjusting the operating conditions of the equipment to process them in a differentiated manner.

As a result, there is a perception that the increasing use of PLA may hinder the measures already implemented to recycle plastics (Lifeder 2023). However, Mexican companies have taken action to accept these materials and use them in the manufacture of filaments for 3D printing, or in the manufacture of panels or plastic materials that look like wood.

4. Market Overview

The global bioplastics market is growing rapidly, driven mainly by environmental concerns about pollution from the use of plastics, particularly single-use plastics for disposable products. This processing has favored the incorporation of bioplastics as raw material, especially in the packaging industry. While bioplastics are not a new material, their application has been concentrated in sectors such as medical, agricultural, automotive and, more recently, the food industry.

According to one estimate, the global biodegradable plastics market reached a value of US$3.982 billion in 2024 (Global Growth Insights 2024), while another estimate for 2024, taking 2023 as a benchmark, was US$2.482 billion (Data Bridge Market Research 2024). The market in 2022 was reported to reach US$7.060 billion, with an expected growth rate of 20.03 percent between 2022 and 2030 (The Brainy Insights 2024).

Although there are discrepancies between estimates, depending on the source consulted, they all agree in showing an accelerated growth in the use and consumption of this raw material, driven mainly by the market's growing preference for biodegradable and more-sustainable products, and increasingly strict regulations aimed at reducing emissions into the atmosphere and reducing the environmental footprint of plastics.

Bioplastics—such as polylactic acid (PLA), polyhydroxyalkanoate (PHA), bio-based polyethylene (bio-PE) and bio-based polypropylene (bio-PP)—are materials that could well replace traditional plastics such as polyethylene terephthalate (PET), polyethylene (PE), polypropylene (PP) or polystyrene (PS). Bioplastics account for less than 1 percent of the 400 million tons of plastics generated each year (European Bioplastics 2024, and Plastics Europe 2023).

The main producers of bioplastics are Asia, Europe and the United States. Mexico is a net importer, and Europe and Asia Pacific are the largest markets in the international context.

The biodegradable plastics of greatest interest and consumption, by type, are:

- polylactic acid (PLA),
- starch mixtures,
- biodegradable fossil-based polyesters (PHAs), and
- others (cellulose, starch or sugar cane).

Applications of biodegradable plastics of greatest interest and consumption include:

- packaging and bags,
- consumer goods,
- agriculture and horticulture,
- textiles,
- medical, and
- others.

In addition to technological innovation, country-specific regulatory frameworks and growing environmental concerns, the bioplastics market is influenced by multiple other factors. These include changes in the behavior of consumers and of companies, which are looking for biodegradable and compostable resins, as well as products made from these materials, in order to remain competitive in an increasingly demanding environmental market. However, this transition implies higher production costs, which are passed on to the end consumer. This has a direct impact on consumption levels and the dynamics of the bioplastics market.

Bioplastics are distinguished from conventional plastics by their ability to degrade through bacterial action and transform into essential compounds such as water, carbon dioxide (CO_2) and other elemental compounds when these materials are processed by composting or biodigestion. However, this characteristic also poses challenges related to storage, distribution and shelf life.

In this context, the research focuses on the following areas:

- obtaining biopolymers from agro-industrial wastes as a solution to final disposal problems in other food applications;
- optimization of fermentation, storage and microbial engineering processes to improve the quality and cost-effectiveness of these materials, and
- development of superior mechanical properties, which enhance food protection by reducing contact with oxygen and moisture.

These advances, together with the adoption of business models, are decisive for the planning and promotion of the bioplastics market in Mexico.

In terms of production capacity, non-biodegradable bio-based plastics together account for about 36 percent (over 865,000 tons) of global bioplastics production capacity, with a downward trend towards 30 percent by 2026 (IfBB 2024). This includes drop-in solutions such as polyethylene (PE), polyethylene terephthalate (PET) and polyamides (PA), all bio-based. In absolute numbers, bio-based polymer production capacities are expected to continue to increase to around 2.3 million tons over the next five years.

While bio-based PET production is on a downward trend, attention has now shifted to the development of polyethylene furanoate (PEF), a material comparable to PET but entirely bio-based, with superior thermal and barrier properties, making it an ideal material for beverage, food and non-food packaging.

Bioplastics applications have similar constraints to those of conventional plastics—the economic aspect together with time and storage conditions being the main barriers to overcome in order to achieve a more widespread use. As biodegradable materials, they are highly sensitive to temperature, humidity and microorganisms that promote their decomposition, all of which has a substantial impact on storage costs.

Table 5 shows the market cost of different types of bioplastics, as well as their biodegradation time. PBS and PHA are among the most expensive alternatives in monetary terms, while TPS and bio-PET are more affordable. Comparing the prices of these materials with that of polypropylene—which in 2024 ranged between US$1.24/kg and US$1.49/kg—shows that PBS and PHA stand out among the most expensive alternatives.

Table 5. Commercial cost of different types of bioplastics, and biodegradation time

Bioplastic		Commercial cost (US$ per kilo)*	Biodegradation time
TPS	Thermoplastic starch	< 1	14–110 days in soil
PLA	Polylactic acid	2.90–3.15	Biodegradable in industrial compost
PHA	Polyhydroxyalkanoate	6.0–6.5	60–365 days in soil, 14–90 days in seawater
Bio-PE	Bio-based polyethylene	1.50–1.70	Non-biodegradable
Bio-PET	Polyethylene terephthalate of biological origin	< 1	Non-biodegradable
PBAT	Polybutylene adipate terephthalate	1.55–1.75	Biodegradable in home compost: 90–365 days
PCL	Polycaprolactone	0.9–1.25	Biodegradable in home compost: 90–365 days
PBS	Polybutylene succinate	6.70–7.40	Biodegradable in home compost: 74–365 days

* Current prices in 2024.
Source: Adapted from M. Ghasemlou, C.J. Barrow and B. Adhikari (2024).

Among the sectors that use bioplastics most frequently are the following:

Packaging and packing: One of the main applications of bioplastics is packaging and packing, which is essential for preserving the quality and prolonging the shelf life of food products. Packaging is classified as primary, secondary or tertiary. Primary packaging consists of the materials that come into direct contact with the product. Secondary packaging contains multiples of individual units and is used for transportation. Tertiary packaging is groupings of products that are in primary or secondary packaging, such as on pallets.

Textiles: In this sector, bioplastics are basically used as polysaccharide fibers or starches. Polylactic acid is experiencing widespread growth and presence in sports and casual wear, lingerie and underwear; starch-based or regenerated cellulose textiles (such as Lyocell or acetate) are used in curtains or upholstery, among other products.

Automotive, electrical and electronics industries: These sectors use bioplastics mixed with other plastic materials to manufacture components in air conditioners, computer mice, small non-essential vehicle parts, cell phones and housings, among many other items.

Health: Bioplastics have long been used as a suitable material for a number of medical applications, including drug capsules, slow-release vehicles, medical and dental implants, tissue engineering, wound protection, and fibers in catheters, to name just a few examples.

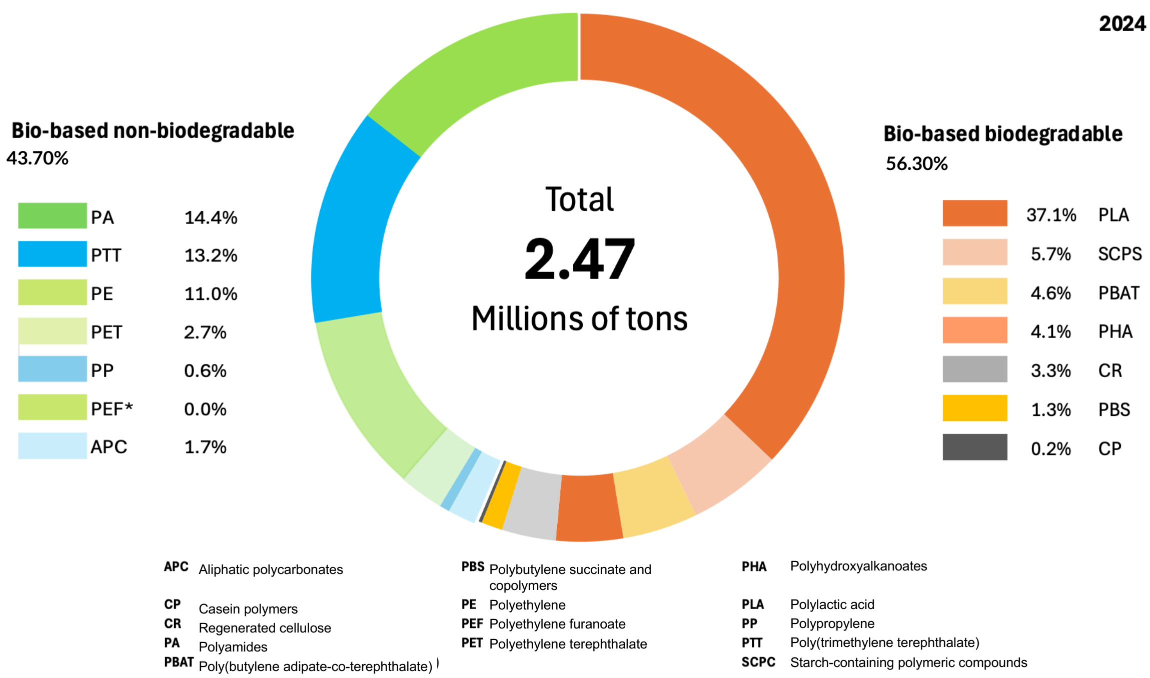
Construction: In Mexico there are companies that have experimented with the recycling of PLA mixed in low proportion with other plastics in the manufacture of panels or plastic wood for furniture.

Agriculture: Bioplastic mulches generically identified as *agrobiofilm*—a type of bioplastic that does not require final disposal—have been formulated to replace conventional plastics. In addition to helping to control weeds and prevent freezing, these materials are also used to make hydrogels, a material used mainly to retain water and release it gradually.

4.1 Overview of material flows and their performance

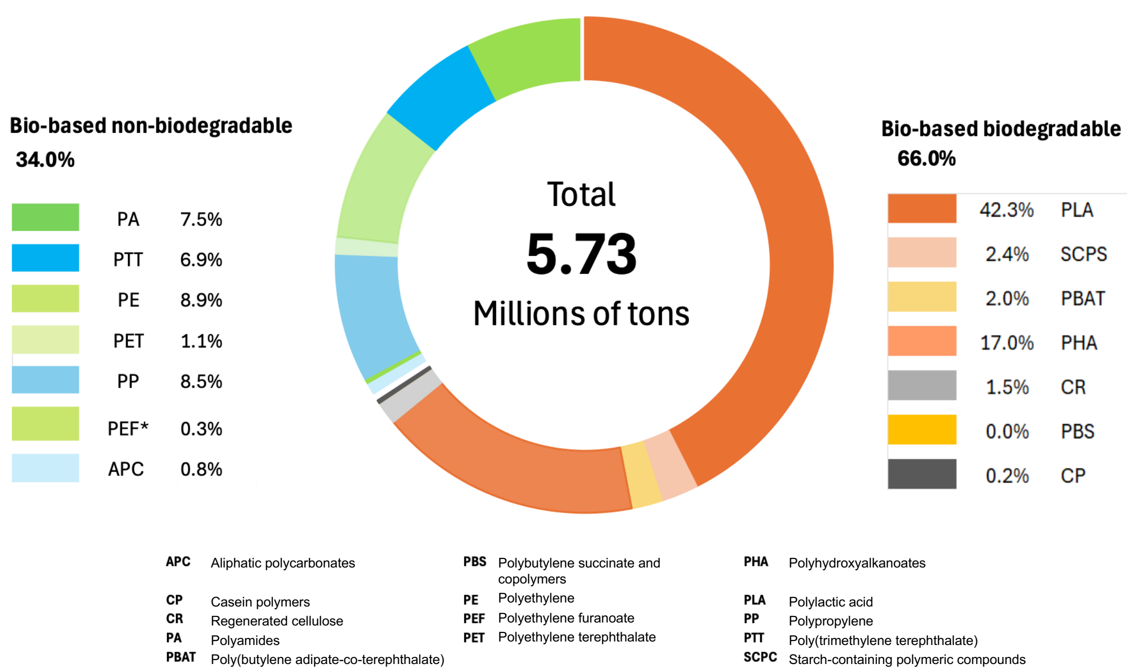
According to European Bioplastics (2024), global bioplastics production capacity is estimated at 2.47 million tons (see Figure 3), although, at present, the industry operates at about 60 percent of its installed capacity. Of this figure, 1.09 million tons correspond to non-biodegradable bio-based materials (44 percent) and 1.38 million tons to biodegradable bio-based compounds (56 percent). The European association forecasts that, by 2029, worldwide bioplastics production capacity will reach 5.73 million tons (see Figure 4): 1.95 million tons of non-biodegradable bio-based materials (34 percent) and 3.78 million tons of biodegradable bio-based materials (66 percent). It should be noted that the packaging sector occupies 45 percent of the total market (1.12 million tons) of bioplastics marketed, although there has been an increase in the variety of applications, highlighting fibers for consumer goods, the automotive industry and the agricultural sector.

Figure 3. Global bioplastics production capacity, 2024



Source: Adapted from European Bioplastics (2024).

Figure 4. Projected global bioplastics production capacity, 2029



Source: Adapted from European Bioplastics (2024).

In Mexico, the manufacture of bioplastics is nascent (compared to petrochemical-based materials) and is being developed on a small scale. Figure 5 presents a summary of the flow of bioplastic resins and compostable bioplastic finished products in Mexico by 2022, which is illustrated with a Sankey diagram.

The design used data on the apparent consumption of bioplastics in Mexico, which is presumed to correspond to the country's trade balance, given the meager production of these materials in the national sphere. Import and export data for bioplastic resins correspond to the following Harmonized Commodity Description and Coding System codes obtained from the United Nations Commodity Trade Statistics Database (UN Comtrade 2024):

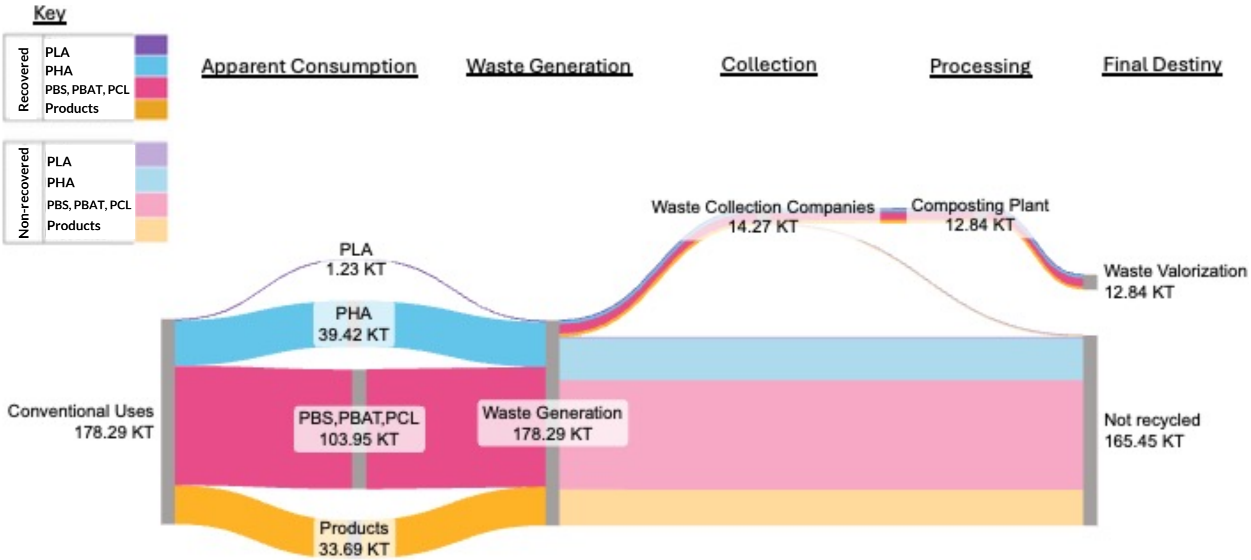
- HS 390770 – Polylactic acid (PLA); in primary forms.
- HS 390791 – Other polyesters, unsaturated; in primary forms (this subset refers to polyhydroxyalkanoate [PHA]).
- HS 390799 – Other polyesters, saturated; in primary forms (this subset includes polybutylene succinate [PBS], polybutylene adipate terephthalate [PBAT] and polycaprolactone [PCL]).
- HS 392329 – Plastics; sacks and bags (including food or drink cones), for the conveyance or packing of goods, of plastics other than polymers of ethylene (this subset refers to compostable products).

Developed on the SankeyMATIC open access platform, the diagram depicts material flows from left to right. An initial node is observed, indicating that these resins and products are for conventional use. Four nodes representing the apparent consumption of resins and products are presented below. This is immediately followed by the waste generation node which, in magnitude, is considered equal to the apparent consumption of resins and bioplastic products disaggregated in the previous nodes. To the right of the waste generation node it is possible to distinguish the recovered waste stream sent for composting and a non-recyclable waste stream. The detailed description of the components of this diagram is included in the following paragraphs.

According to estimates by the Mexican Association of Bioplastics, A.C., 80 percent of net imports of these products remain in Mexico City, of which only 10 percent of the waste is recovered for recovery, although 1 percent of this percentage was material that is not suitable for recycling (AMB 2025).

In 2022, in Mexico, the consumption of resins and products made with bioplastics (initial node) was 178.29 kilotons (kt), which is broken down as follows: 1.23 kt of PLA (0.69 percent), 39.42 kt of PHA (22.11 percent), 103.95 kt of PBS, PAT and PCL (58.30 percent), and 33.69 kt of finished products made from bioplastics (18.90 percent), represented in the apparent consumption nodes. Taking these data as a reference, waste generation is estimated at 178.29 kt (waste generation node), of which 14.27 kt (8.0 percent) is collected (collection node), 12.84 kt (7.20 percent) is recovered in recycling plants (processing node and final destination waste recovery node) and 165.45 kt (92.8 percent) is not recycled (final destination non-recycling node). (AMB 2025.)

Figure 5. Bioplastic waste streams, by type of resin and product, in Mexico, in 2022 (kilotons)



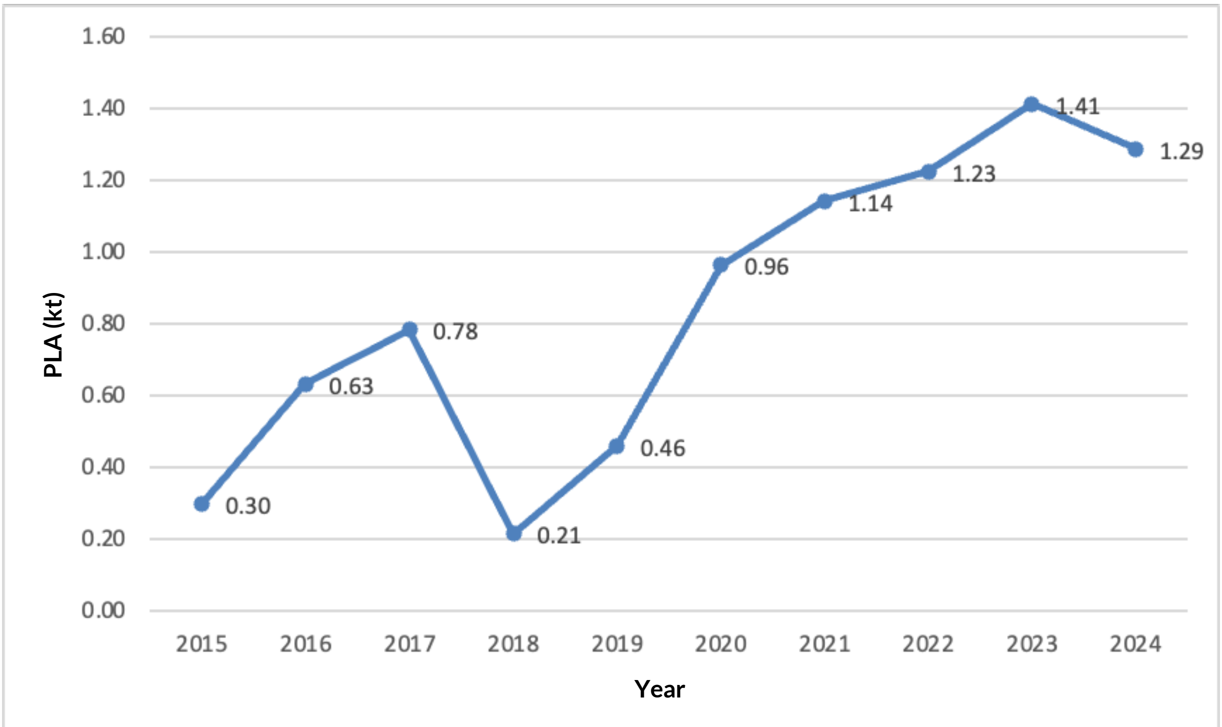
Source: Prepared by the authors with information from AMB (2025) and UN Comtrade (2024).

In 2022 in Mexico, the bioplastics market, in monetary terms, reached US$768,502,567, distributed as follows: PLA, US$3,640,520; PHA, US$110,216,283; PBS, PAT and PCL, US$466,426,041; and finished products, US$188,219,723.

In order to determine trends in apparent consumption by type of resin, the trade balance information reported by the UN Comtrade Database was analyzed over a ten-year period, from 2015 to 2024. In general, it was found that apparent consumption of bioplastics showed positive growth rates during the period.

The apparent consumption of PLA in Mexico between 2015 and 2024 shows an increasing trend, going from 0.3 kt in 2015 to 1.29 kt in 2024, with the highest consumption year being 2023, when 1.41 kt was consumed, while 2015 recorded the lowest consumption: 0.21 kt. The average growth rate of this resin for that period was 35.61 percent, with 2019 being the year of highest growth in consumption, when the year-on-year growth rate stood at 115 percent.

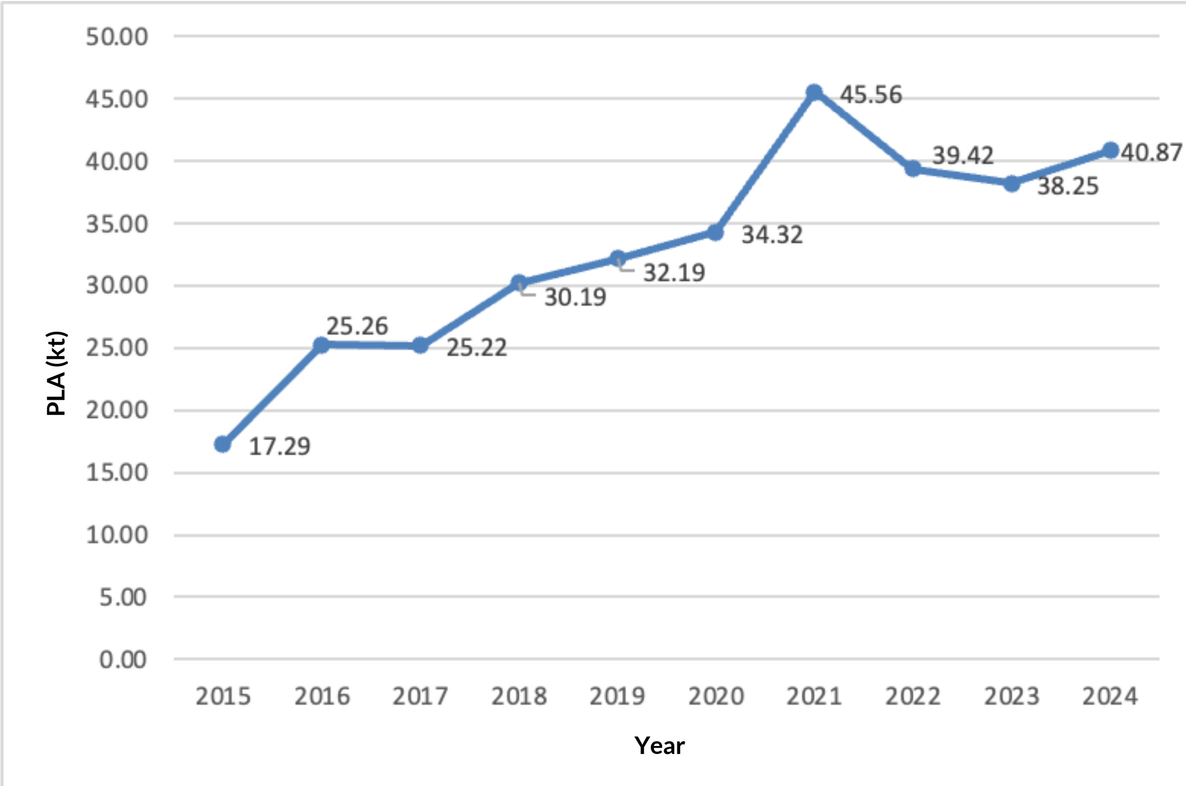
Figure 6. Apparent consumption of PLA in Mexico, 2015–2024 (kilotons)



Source: Prepared by the authors with information from UN Comtrade (2024).

Between 2015 and 2024, the apparent consumption of PHA in Mexico experienced an upward trend, rising from 17.29 kt in 2015 to 40.87 kt in 2025. In the year of highest consumption, 2021, 45.56 kt were consumed, while in the year of lowest consumption, 2015, it was 17.29 kt. The average growth rate of this resin during the period was 11.34 percent, with 2016 being the year that recorded the highest growth in terms of consumption, with a year-on-year rate of 46.13 percent.

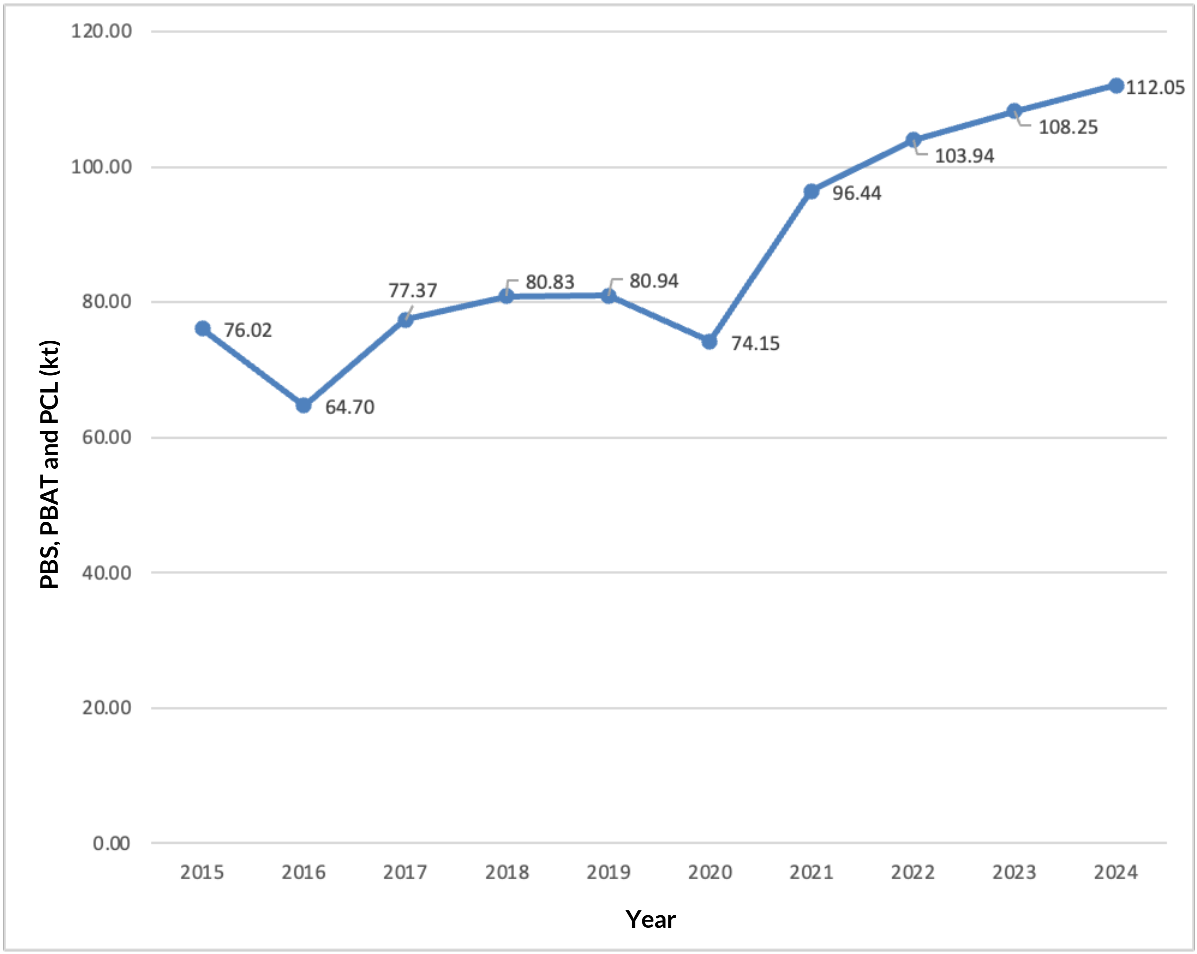
Figure 7. Apparent consumption of PHA in Mexico, 2015–2024 (kilotons)



Source: Prepared by the authors with information from UN Comtrade (2024).

The apparent consumption of PBS, PBAT and PCL in Mexico showed an increasing trend between 2015 and 2024, rising from 76.02 kt in 2015 to 112.05 kt in 2024. The highest level of consumption was recorded in 2024 (112.05 kt), while the lowest was observed in 2016 (64.7 kt). On average, these resins grew at an annual rate of 5.16 percent during the period analyzed, with 2021 standing out as the year of greatest dynamism, with a year-on-year growth of 30 percent.

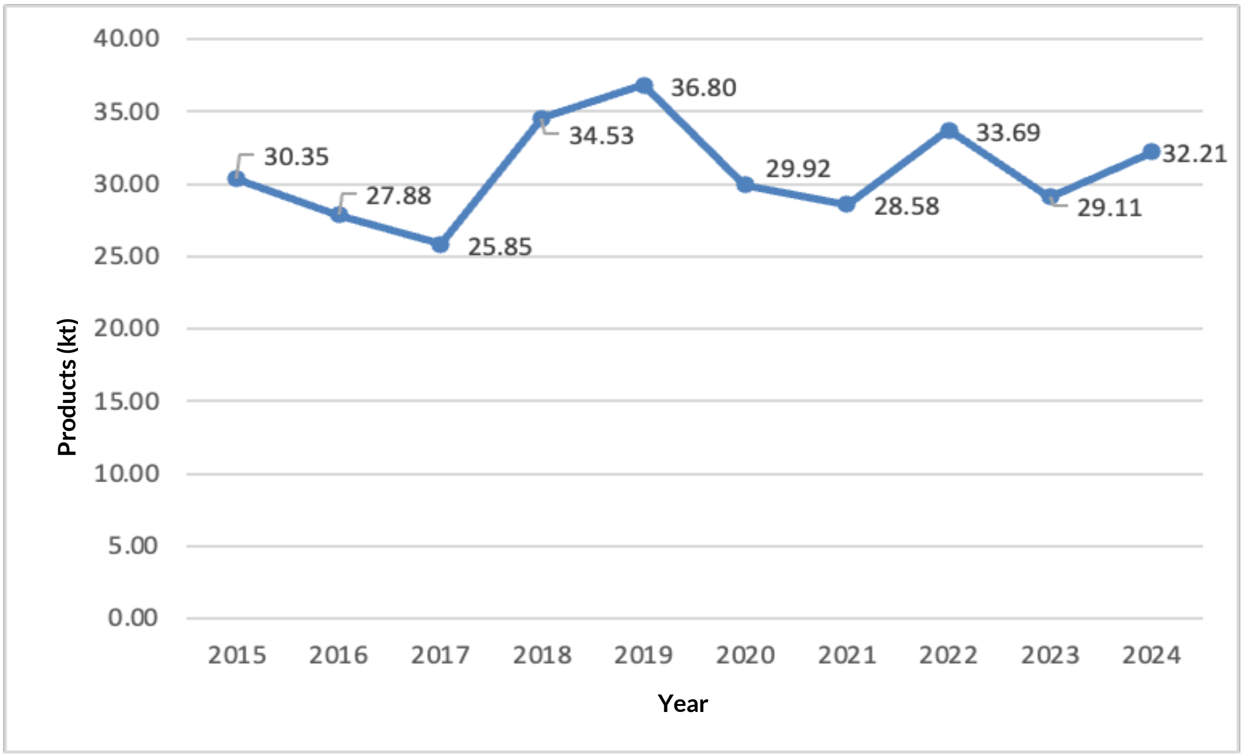
Figure 8. Apparent consumption of PBS, PBAT and PCL in Mexico, 2015–2024 (kilotons)



Source: Prepared by the authors with information from UN Comtrade (2024).

Apparent consumption of products made from bioplastics in Mexico showed an increasing trend between 2015 and 2024, rising from 30.35 kt in 2015 to 32.21 kt in 2024. The highest consumption year was recorded in 2019, with 36.80 kt, while the lowest consumption year was 2017, with 25.85 kt. On average, annual growth during the period was 1.83 percent, with 2018 standing out as the year with the highest growth, with a year-on-year rate of 33.58 percent.

Figure 9. Apparent consumption of products made with bioplastics in Mexico, 2015–2024 (kilotons)



Source: Prepared by the authors with information from UN Comtrade (2024).

In summary, the resin with the highest average growth rate in its apparent consumption over the last ten years is PLA (35.61 percent), followed by PHA (11.34 percent), and PBS, PBAT and PCL (5.16 percent).

5. Secondary Markets

The bioplastics market in Mexico is still incipient and its growth is largely due to social pressures in the national and international spheres, derived from the growing concern about marine and land pollution caused by plastics and microplastics, as well as their impact on the health of living organisms.

The use of bioplastics has largely been fueled by substitution for conventional materials in traditional applications, with the aim of reducing the generation of single-use plastics. These applications include garment packaging, disposable utensils (cups, plates, cutlery and straws) and containers, and packaging made from polyethylene, polystyrene or polypropylene. Some, or even all, conventional plastic products were initially banned in some states in the country, while in others the legislation is more flexible and allows the use of recyclable or reusable materials as long as there is a management plan and a defined strategy for their recovery for recycling purposes, or use of biodegradable or compostable materials (such as PLA, natural fibers or bioplastics) with a plan to ensure that their presence in the environment is limited to a short time and that they degrade into elemental compounds.

Being biodegradable and compostable, bioplastics represent a suitable environmental alternative and contribute to reducing the impact associated with conventional single-use plastics. At the same time, legislation promotes the sending of such materials to composting or, in the case of bags, promotes their application in the containment of organic waste and their disposal through local cleaning systems.

However, due to their low value, the recovery of these materials does not interest garbage pickers: it takes a large number of units collected to amass one kilo of material, and the market price is low or zero.

The government does not have industrial composting plants, and the production of these materials is not of interest to the private sector due to the high costs and because the sale of compost is not very attractive as a business.

In academic institutions, however, composting initiatives are gaining increasing interest as a technical training strategy, although these institutions lack certified or recognized facilities as industrial plants for processing post-consumption waste that includes compostable or biodegradable materials.

For the benefit of the environment, there is a need to replace fossil-based plastic raw material with bioplastics, with their shorter and natural biodegradation process. Under extended responsibility schemes, the private sector would take charge of the recovery of post-consumption waste and ensure that it is sent to composting facilities.

However, this would involve a parallel collection system, with the respective associated environmental impacts, such as fuel consumption, road congestion and the generation of atmospheric emissions, in addition to the challenge of separating waste that the population continues to dispose of in a mixed manner through the cleaning system.

Although the Mexican Bioplastics Association has undertaken actions to recover materials and send them for composting, which would complete the expected cycle for bioplastics, there are still no reports available on the volumes processed under this scheme.

At the international level, guidance on the fate of bioplastics seeks to ensure that, if released into the environment, they degrade in less time than conventional plastics, which would reduce the impact on wildlife and marine ecosystems. It should be noted that in European countries and, in general, in developed economies, the existence of more-efficient cleaning systems reduces the presence of these wastes in the environment.

In Mexico, post-consumption bioplastic waste is destined for composting facilities as a first option; however, as already mentioned, these materials are not recovered, due to their low economic value for the people who collect them, as well as the lack of interest of the collection centers and the lack of certified industrial composting plants, public or private, to receive them systematically. As a result, there is no functional secondary market for the recycling or recovery of post-consumption bioplastics, which means that most of them end up mixed with other municipal solid waste and sent to final disposal, either to sanitary landfills (in the best of cases) or to controlled or uncontrolled disposal sites. This context significantly limits compliance with the principles of circularity in the handling of this type of materials.

5.1 Bioplastics value chain infrastructure

The infrastructure for bioplastics in Mexico is conditioned by two main factors: first, the country does not produce bioplastics, but only transforms them into products, mainly containers and packaging; second, the recovery of bioplastic waste is practically non-existent, due to its low or non-existent market value.

In terms of raw materials, the supply is concentrated in imported PLA, PHA, starch, PBAT, PBS and cellulose fibers from sugarcane bagasse, among other sources, which are purchased by importing companies and sold to processors to produce mainly containers and packaging. Although there are small domestic companies that are beginning to manufacture bio-based pellets from agro-industrial waste, their scale of production is still marginal.

With respect to waste management, there are no specific facilities in Mexico for the recovery, treatment and use of post-consumption bioplastics. Some isolated endeavours in Mexico City have sought to channel these materials to composting plants, but the volumes recovered are minimal. Added to this is the difficulty of separation: in practice, the population does not distinguish between conventional plastics and bioplastics, and disposes of both together with organic waste in bags made from corn or potato starch. As a result, bioplastics are disposed of and managed in the same infrastructure used for municipalities' municipal solid waste (MSW).

5.2 Post-consumption waste collection of bioplastics

Based on requirements outlined in the Political Constitution of the United Mexican States, the cleaning system is a municipal public service that includes the collection, transfer, treatment and final disposal of waste. This service may be associated with a fee or tax, although, in practice, very few municipalities charge for it; in general, it is free of charge and is supported by voluntary contributions from citizens to the operators.

To deal with post-consumption waste, the cleaning system should be equipped to receive waste separated at source. However, this condition is only met in some cities (mainly state capitals) where separation is limited to two subsets: organic and inorganic. Only a few municipalities include additional categories such as paper, glass or mixed waste.

In this context, it is common to find bioplastic waste (such as cups or containers made of vegetable fibers or PLA) mixed with waste collected on public roads. The same is true for carryout bags made from bio-based materials (corn, beet or potato starch), which are generally disposed of with the inorganic subset when used to contain and deliver waste to the cleaning system. In addition, a frequent habit of the population is to knot bags tightly when using them to transport products, which makes their reuse difficult as they have to be torn to remove the purchased products, thus reinforcing their single-use character.

Between the 1970s and 1980s, a strategy was implemented for use of refuse containers on public streets, for disposal of domestic waste, because household collection was so deficient. But the public would turn against this arrangement when the containers were left full and frequently overflowing, cultivating a bad urban image and the presence of undesirable fauna such as rodents and insects. So the practice was eliminated in many communities. When such a plan is well managed, however, with containers kept in good condition 24/7 and maintained with a fill level of no more than 75 percent of their capacity, it has proven successful and the system contributes to reducing the use of collection vehicles while providing citizens with a permanent means of disposing of their waste.

According to INEGI data, only 816 of the country's 2,475 municipalities have a collection system that includes on-street containers, reflecting the limited coverage of this type of infrastructure nationwide (INEGI 2023).

Table 6. Municipalities, by state, using on-street collection containers, 2023

State	Number of municipalities with containers
Aguascalientes	11
Baja California	3
Baja California Sur	3
Campeche	7
Chiapas	39
Chihuahua	25
Mexico City	9
Coahuila	17
Colima	3
Durango	19
Guanajuato	33
Guerrero	24
Hidalgo	54
Jalisco	52

State	Number of municipalities with containers
Mexico	58
Michoacán	57
Morelos	18
Nayarit	5
Nuevo León	18
Oaxaca	81
Puebla	61
Querétaro	12
Quintana Roo	7
San Luis Potosí	26
Sinaloa	7
Sonora	26
Tabasco	11
Tamaulipas	11
Tlaxcala	7
Veracruz	67
Yucatán	30
Zacatecas	15
Grand total	**816**

Source: INEGI (2023), basic tabulations.

If a municipality decides to implement a specific system for the collection of bioplastics, it is essential to first guarantee the supply of sufficient containers for the separate collection of not only bioplastics but also organic and inorganic wastes, as established by the General Law for the Prevention and Integral Management of Waste (LGPGIR).

In Mexico, the maximum separation of municipal solid waste usually involves four waste subsets: organic, recyclable inorganic, non-recyclable inorganic, and bulky and special-handling waste.

In Mexico City, post-consumption bioplastic waste is included in the organic subset, in accordance with the NADF024-AMBT-2013 standard, which also defines the possible types of use of these materials. In general, municipal schemes tend to simplify separation into three subsets: organic, recyclable, and non-recyclable inorganic. In some cases, specific categories are added, such as bulky waste or multilayer packaging.

One of the main challenges is that bioplastics have a similar visual appearance to conventional plastic, which generates confusion among the population regarding their proper disposal. This similarity increases the risk that they will be incorrectly deposited in the inorganic subset, which prevents their recovery through composting or other processes for organic waste. When these materials are mixed in the inorganic subset or recovered for recycling together with conventional plastics, technology is required for their correct separation, and Mexico does not have specific and sufficient infrastructure to process them.

Therefore, creating greater knowledge and awareness among the population regarding the proper management of bioplastic waste is essential: the public must have clear information on the correct subset to which a product belongs so that it can be properly disposed of. Likewise, in order for these materials to be managed through mechanical recycling, the industry must have adequate technology for handling post-consumption bioplastic waste, technology which, at the time this study was prepared, is practically non-existent in the country.

5.3 Biodegradability, recycling and recovery of bioplastic waste in Mexico

The main advantages of bioplastics over conventional plastics are their biodegradability and compostability, characteristics that consumers perceive as an answer to reducing environmental impact.

In Mexico, regulations establish that bio-based and biodegradable bioplastic waste can be disposed of through the cleaning system, within the organic subset, and then sent to industrial composting (aerobic processes) or anaerobic digestion (AD) plants. In the former, materials are transformed into carbon dioxide (CO_2), water and biomass; in the latter, they degrade to form methane (CH_4) and other compounds that make up biogas.

In the case of “compostable carryout bags,” the recommendations are to reuse them for organic waste management and thus dispose of them through the cleaning system. However, this practice generates complications in the cleaning system: contact with organic matter impregnates the bags with odors and waste, making it necessary to wash them—for example, with chemical compounds such as hot caustic soda—in order to eliminate or reduce the odor and remove additional waste.

In the mechanical recycling, bioplastic waste must be separated, subjected to intense washing to remove any odor or impurities, and evaluated according to its mixture with other materials (film or rigid), as would be the case when recycling bags with PLA cups or with a mixture of bioplastics.

At present, there are no plants in Mexico dedicated exclusively to this process, and in conventional mechanical plastic recycling facilities, bioplastics are considered waste, since there is no industry to reincorporate them, so they are delivered to the cleaning system for final disposal. Equipment such as the *hydropulper*, used in the paper industry, make it possible to separate plastics from paper or cardboard cups, but the waste generated is difficult and costly to reprocess and usually ends up in final disposal.

Other technologies, such as gasification to produce alternative fuels similar to diesel, have had occasional applications but without long-term continuity.

Based on the above, the most viable final destination for bioplastics is industrial composting, the viability of which depends on government investment and the creation of a formal market for compost. The states that were identified in this study as having community-based programs or state composting plants are listed below. (Note that, while Mexico City is not a state but a federal district with equivalent powers, for the purposes of this study it will be classed as a state.)

- **Mexico City:** Bordo Poniente plant processes waste from the *Central de Abasto*, public markets, urban pruning and household waste. The compost is used for reforestation, urban gardening or sale to agricultural producers.
- **Querétaro (Querétaro):** Sanitary landfill plant with a capacity of 150 tons per day, where the waste processed is separated at source or associated with community environmental education campaigns.
- **Nuevo León (San Pedro Garza García)**: Municipal plant that processes pruning and garden waste, where the compost is distributed free of charge to citizens and for use in public green areas.
- **Jalisco (Zapopan)**: Municipal plant and community modules, with a total capacity of more than 2,000 tons per year (5 tons per day) to process green waste.
- **Yucatán (Mérida)**: Plant in the municipal sanitary landfill for the use of organic waste from pruning and markets, complemented with workshops and community composting.
- **Jalisco (Tlajomulco de Zúñiga)**: Municipal composting plant that processes waste from mandatory separation, with school composting programs.
- **Michoacán (Morelia):** Plant inaugurated in 2022 to process organic waste from markets, pruning, restaurants and citizens on a voluntary basis.
- **Puebla (Puebla):** Municipal plant in sanitary landfill, for processing green waste to supplement the state's green points and environmental education.

However, the free delivery of compost or its delivery as a component of community or educational bonding discourages the consolidation of a composting market. In addition, the presence of contaminants such as glass, metals and plastics entails great efforts to ensure that biodegradable and compostable products are separated in these plants and that the quality of the final product or compost is high enough for sale and distribution. These factors represent the main barriers to boosting a compost market that includes the reception of bioplastics, whether in bags or PLA cups or with other bio-based bioplastics.

An exceptional case is Mexico City, where certain quantities of bioplastics are accepted in its composting process.

In general, organic waste management in Mexico depends on municipal waste management systems, which operate with collection vehicles, transfer stations and final disposal sites. Although some municipalities have composting or even biodigestion plants (mainly for processing waste from slaughterhouses or sludge from wastewater treatment plants), the supply of infrastructure is still minimal. As a result, most organic waste (including bioplastics) is destined for a sanitary landfill or open disposal site.

The country's new policies and regulations encourage the use of available infrastructure for the recovery of all types of waste, including bioplastics.

The problems associated with cleaning systems, such as limited coverage, obsolete infrastructure, lack of budget and absence of specific fees for waste management, treatment and disposal, in general, apply equally to bioplastic waste management.

In its fourth report, the National Agreement for the New Plastics Economy shares data submitted by 80 companies, indicating that 60,504 tons of conventional plastics were replaced or eliminated. Of this figure, only 196 tons corresponded to substitution with bioplastics in 2023 (Anipac 2023b).

6. Regulatory Framework

The regulations applicable to bioplastics in Mexico are usually found in the regulatory framework for conventional plastics and, occasionally, in provisions related to municipal solid waste (MSW) or special-handling waste.

The formulation of new public policies has a direct—and even indirect—impact on the shaping of a regulatory framework for bioplastics, since restrictions on the use of single-use plastics have an impact on a more widespread application of bioplastics or of additives that accelerate their degradation in the environment. The private sector considers bioplastics to be a desirable alternative for conventional plastics in some applications, thus enabling the sector to continue with its economic activities.

In Mexico, the regulation of plastics is closely related to public policies and international trends in the circular economy, promoted by the Ellen MacArthur Foundation, agreements on plastic pollution (including marine pollution), the Global Alliance for Action Against Plastic and agreements signed with Mexican states, as well as various initiatives of the United Nations Development Program (UNDP) on the environment, resilience, sustainability and, of course, plastics. All these elements have influenced the shaping of national public policies regarding the prohibition and restriction of single-use plastics.

However, this new national policy structure needs to be complemented with instruments that provide certainty to the private sector, clearly defining the direction of actions related to plastics and their impact on the environment and public health.

In Mexico, public policy on waste is the responsibility of the federal government and, in particular, of the Ministry of the Environment and Natural Resources (Semarnat), which also publishes the Diagnosis of Prevention and Integral Waste Management (DBGIR), a document that covers all types of materials, from hazardous, oil and mining waste to special-handling waste and MSW. Public policy is strengthened by the National Prevention and Integrated Management Programs (PNPGIR) for Municipal Solid Waste (MSW) and Special Handling Waste (SHW), as well as by the Mexican Official Standards (NOMs) and Standards (formerly Mexican Standards, or NMX).

Established in the legal framework, public policy determines the direction the country must follow, although its impact is limited to the current administrative period, particularly with short-term instruments. These latter include the National Program for the Prevention and Integral Management of Waste, in its version for MSW and SHW. NOMs and Standards (formerly NMX) are subject to revision, updating or revalidation of their content every five years, while national diagnostics are updated only occasionally for some states, and very rarely for municipalities.

All these instruments make up the procedures and environmental management to be carried out by the companies in their operations. Bioplastics are included in this reference framework, although there is a lack of specific regulatory instruments for their production, use, handling and recycling or recovery, with final disposal being the only mechanism referenced.

One aspect to note is that, in the area of plastics, regulation in Mexico advanced first at the state and local levels, with the establishment of restrictions and prohibitions, rather than at the federal level, and possibilities were opened up for changes in raw materials from conventional plastics to bioplastics and other reusable plastics. This highlights the deficiencies or non-existence of a regulatory framework in this area.

This situation makes evident the need to homologate local and national legislation, based on the same public policy, in addition to creating instruments that allow for the proper bioplastic waste management in areas already explored, such as composting or mechanical or thermal recycling, supported by the proper implementation of management plans and their future transformation into extended producer responsibility schemes.

In this context, the concept of *circular economy* (CE) takes on enormous relevance: Although its general definition—extending the useful life of materials, reducing the consumption of virgin raw materials (mainly from non-renewable sources) and protecting environmental and human health—is understood by all sectors, its application requires differentiated actions that help to resolve in a timely manner the various conditions concerning the life cycle of a material. In the case of bioplastics, their potential as an alternative to conventional plastics is uncertain in terms of their handling, recycling and recovery, which raises questions about their effectiveness as a solution to the problem of plastics and their applications.

CE incorporates innovative approaches such as remanufacturing, repair (as a mechanism to extend useful life and replace only the necessary element) and "service delivery," in an attempt to change the traditional approach to individual purchase and ownership for a myriad of products. However, despite its widespread application to products of daily use by the population, it has not generated the expected results, although it represents a step in the right direction.

In conclusion, the regulatory framework in Mexico focuses on the management of MSW and, more recently, on conventional plastics, and incorporates bioplastics as special-handling waste, but does not provide a clear definition. In addition to considering only conventional plastics, the regulation indirectly provides elements or bases for the incorporation of bioplastics as novel materials with environmental value. Using the elements described above, the current regulatory framework in Mexico is described in the following section.

6.1 Summary of the regulatory and normative framework at the federal, state and local levels

At the federal level (see Table 7, below), bioplastic waste is not explicitly mentioned in current regulations; however, it can be considered within the most recent provisions on plastics, which generally encourage the substitution of conventional plastics with biodegradable and compostable materials.

Indirectly, these wastes are contemplated in the LGPGIR and NOM-161-Semarnat-2011, in which bioplastics are incorporated in specific post-consumption waste and goods plans, mainly in Mexico City, as a strategy to substitute for virgin raw materials. However, the regulation does not explicitly mention them, although it does consider the procedure by which the states may propose the incorporation of new wastes to their lists. By 2025, there were at least 17 authorized management plans, both at national and state level, for compostable products and bioplastics, which establish differentiated management in order to promote their recovery.

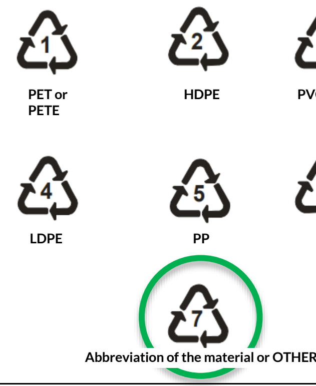
Regarding bioplastics composting, NMX-AA-180-SCFI-2018, in addition to NOM-004-Semarnat-2002, represents the closest technical reference. Although bioplastics are not included in the list of compostable organic waste, due to their microbiological characteristics they can be considered part of this group.

Likewise, at least five Standards (formerly NMX) related to bioplastics were identified which, despite not being mandatory, serve as technical references to standardize terminology, test methods, and identification and evaluation of compostability, with NMX-E-273-NYCE-2019 being the technical reference for certifying compostable bioplastics in Mexico.

Table 7. General characteristics of environmental regulations at the federal level with an impact on bioplastics in Mexico

Instrument	Date of publication	Scope of application and general description	Impact on bioplastics
LGPGIR and its Regulations	2003	National. Establishes public policy on waste, including municipal solid waste and special-handling waste, as well as hazardous, mining and oil waste.	Establishes guidelines for the management of waste, including *bioplastics*, generated in different productive activities and by different sources (industry, commerce and the service sector, among others), as well as the obligation to prepare plans for their management. The initiatives of reforms and additions to the LGPGIR seek to incorporate bans on single-use plastics and circular economy principles. This implies that, in addition to reducing the consumption of conventional plastics, the use of alternative materials, such as *bioplastics*, will be promoted.
Mexican official norms and standards on waste management			
NOM-161-Semarnat-2011	2013	National. Establishes the criteria for classifying special-handling waste (SHW) and determining which wastes are subject to a management plan, and contains a list of these wastes.	Establishes the criteria for classifying SHW, and leaves it up to the states and municipalities to determine which wastes are subject to a management plan. At present, neither *plastics* nor *bioplastics* are included. This instrument seeks to increase the use or recovery of SHW. Currently, there are national and state-level management plans for the management of different post-consumption plastic waste streams such as: PET, HDPE, LDPE, PS, PP, PE and their variants. Based on regulations and bans on plastics established by state authorities, specific management plans for compostable bioplastic products are expected to be submitted, mainly in Mexico City (as of 2025, 16 plans have been authorized and are in force).
NOM-004-Semarnat-2002	2003	National. Establishes maximum permissible limits for contaminants in sludge and biosolids.	It is mandatory for municipal and industrial sludge and biosolids generators, so it can be applied in conjunction with NMX-AA-180-SCFI-2018. Although it does not expressly regulate the issue of bioplastics, it can be implemented when these wastes are integrated into the composted organic subset. If a bioplastic degrades together with organic waste and generates biosolids, these must comply with this standard for use in soils.

Instrument	Date of publication	Scope of application and general description	Impact on bioplastics
NOM-083-Semarnat-2003	2004	National. Establishes the environmental protection specifications for site selection, design, construction, operation, monitoring, decommissioning and complementary works of MSW and SHW disposal sites.	Establishes environmental protection specifications for the selection and closure of final disposal sites for MSW and SHW. It also promotes pre-treatment for the organic subset, such as composting. This standard does not regulate the composting of bioplastic waste as such, but it does recognize it as a prior, desirable practice and part of the integrated management of organic waste.
NMX-AA-022-1985	1985	National. Establishes the selection and method for the quantification of by-products contained in solid waste.	The list of by-products contained in this standard should be updated to include current subsets, and be applicable for the correct quantification of plastic and bioplastic waste streams.
NMX-AA-061-1985	1985	National. Establishes the selection and method for determining solid-waste generation.	Establishes the method to determine, based on statistical sampling, the generation of solid waste. This standard is applied in conjunction with NMX-AA-022, and its list of by-products includes plastics, so it could include bioplastics.
NMX-AA-180-SCFI-2018	2018	National. Establishes the technical methods and procedures for composting and vermicomposting the organic subset of MSW and SHW.	Establishes the quality classification for compost and vermicompost. It is not mandatory, but can be applied to both municipal and industrial-scale composting in Mexico. This standard should be updated to include current subsets and applied to the incorporation of bioplastics.
Standards applicable to bioplastics			
NMX-E-260-CNCP-2014	2015	National, of a voluntary nature. Defines terminology of bioplastic materials.	Establishes the official terminology to be used in Mexico to describe these materials in three categories: bio-based-biodegradable, bio-based-non-biodegradable and derived from fossil sources but biodegradable.
NMX-E-232-CNCP-2011	2015	National. Plastics industry. Establishes plastic identification symbols.	Establishes and describes the identification symbols that products made of plastic must carry. This standard should be updated to include a symbol for bioplastics, which currently use number 7 ("Other").

Instrument	Date of publication	Scope of application and general description	Impact on bioplastics
			
NMX-E-267-CNCP-2016	2017	Plastics industry, bio-based plastics and test methods.	Establishes two test methods to determine the content of biological origin in resins and plastic products manufactured, marketed or distributed in Mexico. This standard supports environmental declarations or eco-labels to verify whether the bio-based product meets the established criteria. It aligns with standards such as NMX-E-260-CNCP-2014 (terminology) and NMX-E-273-NYCE-2019 (compostability).
NMX-E-273-NYCE-2019	2020	Plastics industry; compostable plastics, and specifications and test methods.	Establishes the requirements that plastic products and materials must meet to be considered compostable, in order to ensure that they biodegrade in less than six months and to be able to certify bioplastic products. This standard defines four criteria: biodegradation, physical disintegration, absence of negative effects in the composting process and quality of the final compost. It is based on ISO 17088:2021, and references NMX-E-260-CNCP-2014, NOM-004-Semarnat-2002, ASTM D6400, EN 13432 and ISO 14855.
NMX-E-060-NYCE-2020	2020	Plastics industry and associated terminology.	Establishes terms related to plastics and criteria, to unify terminology. This standard modifies and adapts ISO 472:2013 (*Plastics-Vocabulary*) to the Mexican context. It serves as a terminological reference for standards such as NMX-E-273 (compostable plastics) or NMX-E-267 (bio-based content).

Source: Prepared by the authors based on information from: Semarnat (1985a, 1985b, 2002, 2003, 2011, 2013) and Secretaría de Economía (2018).

As mentioned above, some Mexican standards are based on technical specifications of international standards. The main applicable international standards are detailed in Table 8.

Standards such as EN 13432, ISO 17088 and ASTM D6400 are key references for certifications such as those of OK compost, BPI and NYCE. Standards NFT51-800, AS 5810 and AS 4736 allow validation of compostability under both domestic and specific industrial conditions. Likewise, ISO 472 and terminology standards such as NMX-E-060-NYCE-2020 contribute to the standardization of technical definitions used to catalog and identify plastics and bioplastics. Finally, standards such as ASTM D5511 and D5526 complement the evaluation of biodegradability in anaerobic (e.g., biodigester) and aerobic (e.g., sanitary landfill, etc.) systems.

Table 8. International standards and certifications referenced in Mexico's regulatory framework

Relevant international standards and references		
Title and year of publication	**General description and approach**	**Applied in standards in Mexico**
EPA 796.3200-1995	*Evaluation of aerobic biodegradation (United States)* Ability of a substance to biodegrade under aerobic conditions.	√
EN 13432-2002	*Compostability of containers and packaging (Europe)* Requirements for compostable and biodegradable containers and packaging. Test program and evaluation criteria for final acceptance of the container or packaging.	√
AS 4736-2006	*Industrial compostability (Australia)* Biodegradable plastic. Biodegradable plastics suitable for composting and other microbial treatments.	√
AS 5810:2010	*Domestic compostability (Australia)* Establishes the requirements for a plastic to be considered compostable in domestic conditions.	
ISO 472-2013	General plastics terminology.	√
NFT51-800–2015	*Domestic compostability (France)* Establishes the requirements for plastics to be considered compostable in domestic conditions.	
ISO 14855-2019	*Aerobic biodegradation in controlled composting (CO_2)* Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions. Method by analysis of carbon dioxide released.	√
ISO-17088-2021	General specifications for compostable plastics.	√
ISO16929-2021	*Industrial composting*	

Relevant international standards and references		
Title and year of publication	**General description and approach**	**Applied in standards in Mexico**
	Evaluates the physical disintegration of plastic materials under controlled industrial composting conditions.	
ASTM-D6400-2021	*Industrial Compostability (United States) – Environmental Labeling* Specifications for the labeling of plastics designed to be composted by aerobic means in municipal or industrial facilities.	√
ASTM D5511-2018	*Anaerobic biodegradation in digestion* Standard test method for determining the anaerobic biodegradation of plastic materials under anaerobic digestion conditions with high solids content.	
ASTM D6866-12	*Biobased carbon content* Standard test method used to determine the content of biological origin (biobased content) in solid, liquid and gaseous samples, using radiocarbon analysis.	
ASTM D5338-15 (2021)	*Aerobic biodegradation in controlled composting* Standard test method for determining aerobic biodegradation of plastic materials under controlled composting conditions.	
ASTM D5526-18	*Anaerobic biodegradation in simulated sanitary landfill conditions* Standard test method for determining the anaerobic biodegradation of plastic materials under accelerated landfill conditions.	

Source: Prepared by the authors, based on the international standards as listed.

At the state level, 30 of Mexico's 32 states have implemented regulations that prohibit or restrict the use of single-use plastics. As part of these measures, the use of biodegradable materials and bioplastics as sustainable alternatives to conventional plastics is encouraged.

Most state regulatory provisions do not establish specific management for bioplastics, but consider them mainly as substitutes for plastic products. Actions focus on promoting the development and preferential use of products made from compostable, biodegradable or natural fiber materials, in line with circular-economy principles. This approach is particularly visible in states with exclusive circular economy laws, such as Querétaro, Quintana Roo and Baja California.

Twelve states (Aguascalientes, Baja California, Coahuila, Colima, Chihuahua, Durango, Guerrero, Hidalgo, Morelos, San Luis Potosí, Tamaulipas and Yucatán) have adopted additional measures aimed at promoting the production, research and innovation (R&D—research and development) of sustainable materials, as well as incentives for industry and commerce to adopt their use. In the case of Sonora, incentives aimed at the adoption of these materials stand out.

In addition, five states (Baja California Sur, Mexico City, Jalisco, Nuevo León and Zacatecas) have issued environmental or ecological standards to regulate bans on post-consumption plastics. These standards establish guidelines for the marketing of compostable products and specifications for those considered necessary for hygienic reasons, most of which are compostable bioplastics.

Within the framework of these environmental standards, criteria have also been defined for obtaining local registrations, labels or certifications for compostable products. Most certifications or evaluations by accredited laboratories refer to international standards.

As for differentiated management to ensure the recovery of these materials, only Mexico City's environmental regulation addresses it from a technical point of view. In most of the state instruments on waste, environment or circular economy, composting is mentioned or addressed only as part of the integrated management activities that correspond to the municipalities, without detailing specific technical aspects.

Table 9. General characteristics of the state environmental regulations with an impact on bioplastics in Mexico

State	Instrument	Promotion, restrictions or requirements applied to single-use plastics, with an impact on bioplastics	Initiatives for the recovery or utilization of bioplastics
Aguascalientes	Environmental Protection Act Environmental Protection and Green Areas Management Regulations for the Municipality of Aguascalientes	Substitution with biodegradable, compostable or reusable products, in line with sustainability criteria within the framework of the "Desplastifícate" initiative (<desplastificate.com.mx/>).	No differentiated management is specified for this waste. The regulation establishes that waste must be separated at the source and that municipalities will provide the necessary infrastructure to carry out adequate composting of collected organic municipal solid waste.
Baja California	Environmental Protection Act for the State of Baja California Prevention, Integral Management and Circular Economy Act	Gradual elimination of single-use plastics, and implementation of transitional measures such as the promotion of the use of recycled and biodegradable materials.	There is no specific mention of differentiated management for bioplastics. Both laws establish the separation of waste into at least three categories; MSW (including plastic waste), SHW, and hazardous waste. Composting is recognized as a form of utilization, which

State	Instrument	Promotion, restrictions or requirements applied to single-use plastics, with an impact on bioplastics	Initiatives for the recovery or utilization of bioplastics
			implies the need to separate organic waste.
Baja California Sur	Ecological Balance and Environmental Protection Act Ecological Technical Standard NTE-001-SETUES-2018	Reuse, recycling, and substitution of reusable and compostable alternatives for plastic products, provided that they comply with the corresponding technical specifications and are duly certified. The use of renewable and recyclable raw materials is encouraged.	Neither of these instruments regulates the management of bioplastics, which are only considered as substitutes for plastic products, and their integration into integrated waste management schemes by municipalities is expected.
Campeche	Integral Management of Municipal, Special Handling and Hazardous Solid Waste Act	Restrictions on certain products. The use of biodegradable materials as substitutes is promoted. The "*Campeche sin plásticos*" campaign (<ucs.campeche.gob.mx>) has promoted the transition to alternative materials, including compostable ones, provided they are certified in accordance with NMX-E-273.	It does not directly specify a differentiated management for this waste.
Coahuila	State Ecological Balance and Environmental Protection Act Prevention and Integral Management of Waste Act	A program of substitution and viable alternatives to replace plastic products with biodegradable, compostable or readily degradable products is expected.	It does not directly specify a differentiated classification or management for these wastes.
Colima	Solid Waste Act	The use of sustainable alternatives is allowed, such as **biodegradable or compostable** products, the latter referring to materials that, when discarded, are converted into compost or fertilizer.	It does not directly specify a differentiated classification or handling for bioplastics. The law states that the technical criteria for compost production are established in its regulations.
Chiapas	Solid Waste Act and its regulations	Use of biodegradable containers or containers made of returnable and reusable materials for serving or delivering marketed food is encouraged.	It does not directly specify a differentiated classification or management for bioplastics, but it does for compostable waste (waste from food, parks and

State	Instrument	Promotion, restrictions or requirements applied to single-use plastics, with an impact on bioplastics	Initiatives for the recovery or utilization of bioplastics
		Concepts of single-use plastics and biodegradable materials are incorporated.	gardens, agricultural facilities and other biodegradable waste). The regulation establishes the primary separation of waste into three subsets: recyclable, compostable and non-recyclable. As for composting centers, a list of organic and compostable waste is established.
Chihuahua	Ecological Balance and Environmental Protection Act Prevention and Integral Management of Waste Act	The implementation of educational initiatives aimed at promoting the use of sustainable alternatives is encouraged, with emphasis on the use of biodegradable and compostable bags.	Although the law does not directly mention "bioplastics," it does allow the use of biodegradable or compostable products. Composting is mentioned as part of the integrated management activities, without detailing specific technical aspects.
Mexico City	1. Federal District Solid Waste Act 2. Circular Economy Act 3. Technical environmental standard NACDMX-010-AMBT-2019 4. Environmental Standard NADF-024	1. Prohibition of single-use plastics, with special attention to disposable plastics. 2. Principles and guidelines affecting bioplastics are established. 3. The environmental standard establishes: technical specifications for bioplastic-compostable bags and products; requirements for certification and registration with the authorities; mandatory use of the CDMX "compostable" logo; and criteria for waste management plans.	Environmental Standard 010 states that compostable bioplastics, such as bags, should be used only for organic waste. Its management requires traceability, separation and differentiated handling at the source in order to be properly composted. The Compostable Plastics Guide published in CDMX states that these must comply with standards such as ASTM D6400, EN 13432 or NMX-E-273-NYCE-2019, in accordance with the Environmental Standard NACDMX-010-AMBT-2019. This standard is also consistent with NADF-024 for the identification and separation of inorganic waste and waste with recycling potential.

State	Instrument	Promotion, restrictions or requirements applied to single-use plastics, with an impact on bioplastics	Initiatives for the recovery or utilization of bioplastics
Durango	Sustainable Environmental Management Act Prevention and Integral Management of Waste Act and its regulations	The need to replace polyethylene products with biodegradable, oxo-biodegradable or compostable materials is recognized.	Although it does not expressly mention "bioplastics," the law establishes *selective collection* as a mandatory system for separating organic and recyclable waste.
Guanajuato	Integral Management of Waste Act	It does not provide for prohibitions or restrictions on plastics.	It does not contain information related to bioplastics.
Guerrero	Act 593 for the Integral Use and Management of Waste Ecological Balance and Environmental Protection Act 878	Reusable, recyclable or biodegradable products are encouraged.	Act 593 does not explicitly mention bioplastics as a distinct category, but it does mention composting as part of integrated management, which allows compostable materials such as certain bioplastics to undergo appropriate management if they are integrated into the corresponding plans.
Hidalgo	Prevention and Integral Management of Waste Act Environmental Protection Act	Research and development (R&D) initiatives for reusable materials and alternatives to disposable single-use plastics are promoted.	No mention is made of bioplastics.
Jalisco	Integral Management of Waste Act Ecological Balance and Environmental Protection Act State environmental technical standard NAE-Semadet-010-2019	The transition to technologies that use biodegradable, compostable or recycled material from plastic-producing companies is favored. Compostable products are required to comply with standards such as ASTM D6400, EN 13432 or NMX-E-273-NYCE-2019, and be labeled as compostable. State Environmental Standard 010/2019 establishes criteria for compostable bags and straws, and details requirements regarding labeling, composition and certification.	Differentiated handling is considered for compostable materials (such as bioplastics) certified in the technical environmental standard.

State	Instrument	Promotion, restrictions or requirements applied to single-use plastics, with an impact on bioplastics	Initiatives for the recovery or utilization of bioplastics
State of Mexico	Code for Biodiversity	Compostable, recyclable or reusable products are considered alternatives to single-use plastics.	The Code does not detail a differentiated collection system; instead, it establishes that compostable products should not be considered single-use if they meet recovery or compostability criteria. No technical guidelines have been published to regulate this recently issued ban.
Michoacán	Prevention and Integral Management of Waste Act Environmental Conservation and Sustainability Act	Substitution with biodegradable, compostable or reusable materials is encouraged.	Bioplastics are not mentioned and no differentiated management is defined.
Morelos	Solid Waste and Circular Economy Act	Actions aimed at substituting and providing viable alternatives to replace single-use plastics with degradable or biodegradable materials that are compostable.	Not mentioned.
Nayarit	Ecological Balance and Environmental Protection Act	Substitution with biodegradable or compostable materials is required. Sustainable production criteria and standards aimed at promoting the sustainable production of compostable materials are mentioned.	Not mentioned.
Nuevo León	Environmental Act State Environmental Standard NAE-SDS-005-2019	The use of reusable or compostable materials is encouraged. The environmental standard contains specific references to bioplastics. It recognizes that these materials may or may not be biodegradable, which implies that not all bioplastics meet compostability criteria.	The environmental standard addresses general factors for the differentiated management of bioplastics, although in an indirect and limited way, mentioning that any documentation that covers the corresponding biological-origin content of the materials or finished products (bags) throughout the production and consumption chain will have to be presented.

State	Instrument	Promotion, restrictions or requirements applied to single-use plastics, with an impact on bioplastics	Initiatives for the recovery or utilization of bioplastics
Oaxaca	Ecological Balance and Environmental Protection Act Prevention and Integral Management of Solid Wastes Act	No *technical definition* of bioplastics was included, nor were compostable or biodegradable materials differentiated.	Not mentioned.
Puebla	Prevention and Integral Management of Municipal Solid and Special Handling Waste Act	Use of cloth, paper or bioplastic bags is encouraged.	It does not specify a differentiated handling of these materials.
Querétaro	Prevention, Integral Management and Circular Economy of Wastes Act	Use of products with low contamination potential and low waste is promoted, including reusable and compostable packaging.	There is no mention of differentiated management for this waste stream. However, the possibility of reincorporating materials into production processes or into nature is recognized,
Quintana Roo	Climate Change Action Act Ecological Balance and Environmental Protection Act Prevention, Integral Management and Circular Economy of Waste Act (including the Regulation on Extended Responsibility)	Compostable or reusable materials are not promoted as viable substitutes.	There is no mention of differentiated management for these materials.
San Luis Potosí	Environmental Act	Alternative products are required to be biodegradable, compostable or post-consumption recycled, with at least 80 percent environmentally friendly content.	There is no mention of differentiated management for these materials.
Sinaloa	Waste Act	Biodegradable products must be certified by the Mexican	There is no mention of differentiated management

State	Instrument	Promotion, restrictions or requirements applied to single-use plastics, with an impact on bioplastics	Initiatives for the recovery or utilization of bioplastics
		Accreditation Entity (EMA). At least 90 percent of biodegradable materials are required to be traceable and technically validated.	for these materials, although integrated waste management is promoted, namely: separation, recycling, composting and energy recovery.
Sonora	Act Regulating the Production, Management and Final Disposal of Municipal Solid Waste, Special Handling Waste and Single-Use Plastic Products	Creation of tax incentives for industries that transform their products into more environmentally friendly options is promoted.	There is no express mention of differentiated management for these wastes. However, the law provides for a single-use plastics management program, as well as the management and disposal of biodegradable plastics.
Tabasco	Prevention and Integral Management of Waste Act	Use of more-sustainable alternatives, such as biodegradable, compostable, reusable or recyclable bags and straws, in accordance with environmental standard NAETAB-001-SBSCC-2020. No official document is available in this regard.	There is no mention of differentiated management in any of the instruments that address these wastes.
Tamaulipas	Sustainable Development Code	Use of biodegradable, reusable or ecological products is encouraged.	There is no mention of differentiated management for this waste.
Tlaxcala	Waste Act	No prohibitions or restrictions are expected.	Not mentioned.
Veracruz	Prevention and Integral Management of Municipal Solid and Special Handling Waste Act	The aim is to promote the gradual transition to the use of biodegradable materials.	There is no mention of differentiated management for this waste.
Yucatán	Integral Management of Waste Act	Use of raw materials from renewable and recyclable natural resources is encouraged.	There is no mention of differentiated management for this waste. However, a management plan for plastic waste management and public awareness campaigns is expected.

State	Instrument	Promotion, restrictions or requirements applied to single-use plastics, with an impact on bioplastics	Initiatives for the recovery or utilization of bioplastics
Zacatecas	Solid Waste Act Municipal Ecological Technical Standard NTEM-002-ZAC19	Use of biodegradable, compostable or oxo-biodegradable containers is allowed.	There is no mention of differentiated management for this waste.

Source: Prepared by the authors based on the environmental and waste management legislation and regulations in force in 2025 in the 32 federal entities of Mexico, consulted in the respective Diario Oficial de la Federal (DOF) and/or Official Gazettes (Programas de Ordenamiento Ecológico—POE), including state laws on ecological balance, integrated waste management, circular economy and climate change, as well as local environmental technical standards, and applicable municipal provisions, and in conjunction with information from A. Flores et al. (2024).

International and national environmental standards and certifications applicable to bioplastics (compostable, biodegradable and bio-based) are detailed in Table 10.

Table 10. Certifications or references for bioplastic products or materials

Instrument	Date of publication	Scope of application and general description	Application in bioplastics
International in scope			
1. **ISO 14020:** General terms and requirements 2. **ISO 14021:** Self-declaration 3. **ISO 14024:** Ecolabel 4. **ISO 14025:** Environmental declarations for products	1. 2022 2. 2016 3. 2018 4. 2006	International, voluntary	They are applied for labels of various products, with emphasis on environmental criteria.
DIN CERTCO	2000	International, German, based on EN 13232, to evaluate materials and products under domestic and industrial conditions.	This certification validates: - compostable materials such as PLA, PBAT, starch, thermoplastics, and cellulose; - materials of biological origin: biopolymers with a renewable content equal to or greater than 20 percent; - certified products—compostable bags (industrial and domestic use); - compostable coatings for paper or cardboard;

Instrument	Date of publication	Scope of application and general description	Application in bioplastics
			- biodegradable agricultural films.
STA Certified Compost	2000	International, from the United States.	US certification scheme to guarantee the technical quality of compost, a benchmark for producers, buyers and regulators.
Biodegradable Products Institute (BPI)	2002	International, United States, based on ASTM D6400 or D6868 standards, to verify products under industrial conditions.	Verifies that products labeled as compostable actually decompose safely and completely in industrial composting facilities. Certified materials: PLA, PBAT and PBAS, molded fiber, compostable coatings and thermoplastic starch.
BioPreferred® from the United States Department of Agriculture (USDA)	2002	International, based on ASTM D6866 and ISO 17025. The program applies **to both US-made and imported products**.	Designed to promote the use of products made from renewable raw materials such as plants, vegetable oils, cellulose or algae. - USDA verifies the results and issues the certificate with the percentage of bio-based content; for packaging: ≥45 percent

Instrument	Date of publication	Scope of application and general description	Application in bioplastics
Certifications OK compost (TÜV) (Austria)	2003	International, European, to validate compostable products in domestic and industrial conditions. It is based on **EN 13432.**	International benchmarks to validate the compostability of products (mostly PLA and PBAT) in different environments. OK industrial compost: 55–60°C, up to six months. OK compost HOME: 20–30°C, up to twelve months.
Japan Bioplastics Association	2007	International, Japanese, based on **ISO 148855-1, ISO16929, AS 5810:2010, NFT51-800 and ASTM D5511** standards.	Evaluates and certifies products that meet the criteria of: biodegradability: PLA, PBAT and modified starch; biomass (plant) origin: bio-PE, bio-PET, bio-PA; combined: PLA+PBAT.

Instrument	Date of publication	Scope of application and general description	Application in bioplastics
C-Label Compostable Certification	2021	International, based on international standards such as **ASTM D6400** and **ASTM D6868**.	Emerging option that validates the **compostability of both industrial and domestic products**. It is especially relevant for products exported to markets that recognize the ASTM standard as the technical basis.
National			
Clean Industry Certificate	1992	National. Government of Mexico through the Office of the Federal Attorney General for Environmental Protection (Profepa) of the Ministry of Environment and Natural Resources (Semarnat).	The environmental performance of an industry is recognized according to the activities carried out.
Seal and compostability assessment	2019	National. Products are evaluated and certified by NYCE Laboratories.	It is granted in accordance with NMX-E-273-NYCE-2019, which establishes specifications and test methods for compostable plastics. Validates that a plastic product can be safely decomposed under industrial composting conditions.
Compostable seal	2019	State, granted by authorities of CDMX, linked to compliance with **Environmental Standard NACDMX-010-AMBT-2019** and **NMX-E-273-NYCE-2019**, as well as **ISO 17088:2012.**	This seal can be placed on bags, packaging, labels or technical data sheets, and can be used only if the Mexico City Secretariat of the Environment (Sedema) has evaluated and approved the product, after laboratory testing and traceability of waste management.

Instrument	Date of publication	Scope of application and general description	Application in bioplastics
Biodegradability certification seal	2025	National, awarded by Normex. This certification is based on **NMX-E-273-NYCE-2019** and other standards of the Mexican Accreditation Entity (EMA). Detailed information is not yet available on its official website.	It allows validation that a product or material decomposes safely and efficiently under specific conditions, such as composting or contact with soil.

Source: Prepared by the authors.

The establishment of environmental certifications has been decisive in guaranteeing the quality, traceability and sustainability of products made from biodegradable, compostable or bio-based materials, as they allow validation of environmental performance at different stages of the product's life cycle, under voluntary adoption schemes and international recognition.

Internationally, ISO standards have been identified as applicable to sustainable plastic products as a basis for environmental declarations or eco-labeling, which can also be applied to bioplastics. There are other certifications that allow traceability and technical differentiation, from the bio-based renewable origin of the products, to their performance in industrial or domestic composting, such as: DIN CERTCO, BPI, USDA BioPreferred®, OK compost Industrial/Home, Japan Bioplastics Association, C-Label Compostable, and STA Certified Compost.

The three applicable Mexican certifications for bioplastics considered by NMX-E-273-NYCE-2019, as well as the methods and evaluations provided by international certifications and standards (see Table 8), serve as the basis for state regulatory provisions for compostable plastics, especially in CDMX.

These certifications relate to the following determining standards:

- NMX-E-273-NYCE-2019 (compostability)
- NMX-E-267-CNCP-2016 (bio-based content)
- NMX-AA-180-SCFI-2018 (compost quality), in conjunction with NOM-004-Semarnat-2002 (control of pollutants in biosolids)

7. Identification of Best Practices Applicable in the Mexican Context

This section describes good practices applicable to each stage of a product's life cycle, practices designed both to improve the relationship between production and its economic and social benefits and to mitigate environmental impacts.

For the implementation of best practices regarding the bioplastics value chain, those that can be adopted in the procurement and supply stages of raw material and the production stage of bioplastics are discussed, since that is where the greatest benefits are obtained. In the handling stage, on the other hand, these benefits may be lost, depending on the way in which bioplastic waste is recovered, handled, treated or disposed of.

The practices suggested by CEC are highly recommended for optimizing operations, reducing losses and increasing control of human, material and economic resources. For the same reasons, they can also be applied to the biomaterials industry, although with particular considerations regarding the storage of raw materials, due to the tendency of these materials to degrade in suboptimal humidity and temperature conditions, which contribute to accelerating or slowing down their natural process.

Table 11 illustrates the best practices applicable at the raw material procurement and supply stages and the bioplastics production stage.

Table 11. Best practices in raw material management and bioplastics manufacturing processes

Activity	Description	Result
Quality assurance system	Sum of organized and documented provisions that guarantee the quality of imported materials and objects, in order to comply with the functionality of bioplastics.	The requirements for bioplastics for food-contact applications are equally as stringent as for plastics, to ensure adequate safety and quality. Due to the biodegradable condition of bioplastics, the process of disintegration is triggered by poor humidity, temperature and storage conditions.
Documentation	As these are imported materials, proper documentation is of fundamental importance. It is advisable to have a complete record from the manufacturer of the bioplastic in question retained, for review by the competent authorities: a minimum such custody period of two years is recommended.	Folders with the information indicated by the standard and the corresponding laboratory tests.

Activity	Description	Result
Labeling	Labeling helps users to use materials and objects correctly. Although methods may vary, the content of the information is not the only aspect to consider: the material from which the product is made must be taken into account. Inks and adhesives are also elements to be recorded when they have a direct impact on the recyclability of the product.	Documentation compiling the changes made to the labeling, materials and, as a priority, the caps and labels made of the same material as the container. When using inks, it is suggested to opt for water-based or heavy metal–free inks.
Traceability	It consists of recording information on the origin of the biomaterial, its storage time and shelf life, so that the purchasing or importing party can verify the quality and condition of the product.	Traceability in the industry and trade of biodegradable materials aims to control product quality and shelf life, in order to reduce the risk of transferring microorganisms to the final product or changing the functionality of the bioplastic.

Source: Prepared by the authors.

Good practices should be applied taking into account the size of the industry and its financial, technological and personnel conditions, so that the business is profitable. For example, the raw material used in the manufacture of biopolymers—whether from agro-industrial waste or biomass crops—requires controlled environmental conditions necessary to prepare and extract the starches or compounds from which the biopolymers are made. It should be emphasized that these practices are applicable to formal productive activities, not to informal ones, such as those of the garbage pickers or similar.

In Mexico, the main source of biomass for manufacturing bioplastics is agro-industrial waste, such as agave or sugarcane bagasse, starch, cactus, lignocellulosic components, rice husks, sorghum, barley, avocado seeds, mango, guayule fiber, and algae, among others.

In adopting best practices, it is important to consider the origin of the raw material used to produce biopolymers. It is preferable to use non-food resources, in an effort to reduce the ecological footprint resulting from intensive use of soil, water and energy, as well as to ensure a source that is always available in quantity and quality.

When the source of biomass is abundant only seasonally, as in the case of agave and sugarcane bagasse or sargazo, adequate storage must be ensured throughout the year so that bioplastics can be marketed on a regular basis.

Regarding the environmental perspective, best practices applied to the procurement and supply of raw material and to production stages are described in Table 12, below:

Table 12. Best environmental practices in the procurement and supply of raw material and in production stages

Activity	Description
Use of raw materials	It is important to reduce shedding of pellets in the handling of raw materials, in order to reduce the presence of these materials in the environment. The origin of the biomass and its preparation define the usefulness of the bioplastic. In its volume of agro-industrial waste, Mexico has large quantities of biodegradable and compostable raw material to produce bioplastics. The second source of biomass is in its cultivation expressly for this purpose, where the most important thing to consider is to evaluate the extent of competition it poses for food production.
Recycling	While it is true that the recycling of bioplastics is convenient under circular-economy criteria, it is complicated to achieve by mechanical means, since melting points of bioplastics are different from those of conventional plastics. So far, changing raw materials or substituting them with bio-based products, in order to affect the environment as little as possible, and accelerating the degradation time of the materials are a budding goal for public policy.
Energy efficiency	Use technologies and machinery that consume less energy, as well as renewable sources, such as solar or wind power.
Reduction in water consumption	By treating and reusing water, it is possible to reduce its consumption in the production of biomass. The same can be done in mechanical recycling, or when the material is separated from the paper in coated cups or containers. In the production of biomass from specific crops, savings in degradation time are achieved by using technified irrigation methods, such as drip, sprinkling, micro-sprinkling and exudation, among other methods.
Emissions controls	In Mexico, bioplastics are consumed in the form of thermoformed products such as carryout bags, cups or containers, manufactured from pellets laminated from natural sugarcane or bamboo fibers. Emission control in a facility where these products are manufactured is possible by implementing filtration systems and gas treatment to reduce pollutant emissions during production. In the production of bioplastics from the recovery of agro-industrial waste, it is important to consider the control of emissions generated by the vehicles and equipment used in both production and biomass recovery.
Product innovation	Eco-design in product manufacturing is a pillar of circular economy, integrating functionality criteria that encompass material selection, ease of disassembly, repairability and other relevant aspects. In this sense, eco-design should consider mono-material manufacturing, particularly effective in disposable products that come into contact with food, such as cups, clamshells and other packaging. However, when used as a paper cup liner, the separation of the bioplastic or plastic is complex and requires equipment similar to that used in the paper and cardboard industry for separation and sorting.

Activity	Description
	In other applications, adopting a mono-material approach presents a challenge, as blends with other plastics or chemical compounds are often required in order to improve performance properties, such as moisture resistance or reduced oxygen transfer. These issues must be resolved during the design and development stage of new products. Finally, in industries such as the automotive industry, where bioplastics are used in structural components — for example, in shock-absorbing elements or junction boxes — the separation of materials at the end of their useful life is practically unfeasible.
Monitoring and continuous improvement	The implementation of a monitoring system to evaluate the environmental impact and efficiency of the processes, not only for production but also for handling, recycling and recovery, is essential. This monitoring must be continuous and oriented to analyze the behavior of the material in the real conditions of generation and management by the clean-up systems of the country's municipalities. The information obtained facilitates the identification of areas for improvement and adjustments to practices in order to optimize environmental performance at each stage of the material's life cycle.

Source: Prepared by the authors.

The structure of the national policy should be complemented with other instruments that strengthen and provide certainty to the private sector with respect to actions and guidelines regarding plastics, as well as the impact of plastics on the environment and public health.

It is also essential to recognize the need to integrate local and national legislation under a unified public policy, as well as to establish procedures that guarantee the adequate management of bioplastic waste. These procedures should incorporate the routes already identified, such as composting, mechanical recycling and even thermal utilization, and be supported by the proper implementation of management plans that can evolve into extended producer–responsibility schemes.

8. Findings and Recommendations

During the preparation of this study, findings were identified in each stage, section and subsection that enable us to detect areas of opportunity and improvement in the different elements that involve both the public and private sectors.

The identification of these findings is not intended to be taken as value judgments or qualifications of the facts found; its objective is to describe those elements that provide information and knowledge on the current conditions of handling and management of bioplastic waste in the country.

This section is organized around each of the findings identified, followed by the corresponding recommendation(s).

Finding 1

In Mexico, bioplastics are mainly used in the manufacture of single-use products. These products are often used as alternatives in response to bans or restrictions on conventional plastic. The food sector is the largest user, followed by the health sector and, in recent years, by the agricultural, automotive and textile sectors. However, in all cases there is a lack of clear mechanisms for bioplastics recovery, management and recycling.

Recommendation 1. Strengthen the legal framework to cover the complete life cycle of bioplastics manufactured in Mexico, especially when their raw material comes from crops. This is relevant, as the production, import and use of bioplastics is a regulatory-driven activity, rather than a sustainable-production approach.

Recommendation 2. Focus the production of bioplastics on the use of agro-industrial waste, in order to promote the management and recovery of high-volume waste. This would also generate new economic opportunities for the country.

Recommendation 3. Formulate a legal framework at the national or state level that encourages the production of bioplastics from waste, provides certainty for investments and fosters the growth of this market.

Recommendation 4. Design and implement specific economic instruments that promote the production of goods from waste, strengthening the market for bioplastics, biomethane and biomass, while contributing to the management of post-consumption agro-industrial waste.

Recommendation 5. Establish a national policy framework that provides guidelines for waste disposal, with expanded mechanical recycling and thermal recovery options, as well as provide clear communication of these options.

Finding 2

In Mexico there is no specific infrastructure for handling bioplastic waste, which ends up mixed with municipal solid waste and is handled through the conventional infrastructure available.

Recommendation 1. While the separation of organic and inorganic waste is a step forward, it is not enough for a circular economy. In the case of compostable bioplastics, their recovery together with organic waste represents a viable alternative, which requires communication and awareness campaigns to ensure proper implementation.

Recommendation 2. Given that the minimal management of post-consumption waste of bioplastics in Mexico lies in composting, the construction and operation of industrial composting and biodigestion plants for the treatment of organic waste, including bioplastics, should be promoted. This should be complemented with the promotion of compost commercialization as an economic instrument that encourages the creation of infrastructure built to receive bioplastics.

Finding 3

Actors in the bioplastics value chain show little motivation to invest in post-consumption waste recovery, handling and recovery facilities. Recovery through composting generates little economic value, which limits the preparation of management plans and a robust secondary market.

Recommendation 1. Design management plans at the national and state levels that include economic incentives and competitive prices for recovered materials, an indispensable condition for making recycling viable and implementing the principles of extended producer responsibility and circular economy.

Finding 4

The population's level of knowledge about bioplastics is very limited, so the waste generated is handled in the same way as for plastics with no market value, which reduces their potential for material or thermal recycling.

Recommendation 1. Promote information campaigns that involve both government and private initiatives on the properties, advantages, disadvantages, uses and proper management of bioplastics.

Recommendation 2. Implement technical training programs to train personnel specialized in the manufacture, composting, biodigestion and recycling of bioplastics.

Finding 5

Mexico is a net importer of bioplastic resins. PLA has recorded the highest growth in apparent consumption over the last ten years (35.61 percent), followed by PHA (11.34 percent) and, to a lesser extent, PBS, PBAT and PCL (5.16 percent).

Recommendation 1. Encourage the use of exchange hedges that allow producers to plan costs and mitigate the impact of exchange rate volatility on the domestic production of goods made from bioplastic resins.

Recommendation 2. Establish clear labeling and encourage the recovery and differentiated management of this waste for recycling. If the trend continues, the consumption of PLA and PHA and, to a lesser extent, PBS, PBAT and PCL is expected to increase substantially in the near future.

Recommendation 3. Encourage startups in the domestic market and strengthen links between industry and academia in order to accelerate innovation and consolidate the bioplastics value chain.

9. Conclusions

9.1 Conclusions regarding Bioplastics Waste Management in Mexico

The consumption of bioplastics poses significant challenges related to their availability in the market, cost competitiveness and the perception of those who consume these materials. Localization of sourcing and raw material production, leveraging economies of scale, and promoting demand for recycled bioplastics can positively influence market dynamics. It is also essential to dispel misconceptions about their degradability, through appropriate labeling and the use of innovative marketing and communication strategies that strengthen the consumer's perception of the mechanical performance and quality of these materials.

One of the main obstacles to the production and use of bioplastics is their high manufacturing cost, compared to that of conventional plastics, together with the limited or non-existent infrastructure for their adequate recovery. This situation leads to inadequate disposal practices that can neutralize the environmental benefits expected from their use.

The main cost components include raw materials (such as starch, cellulose or vegetable fats) as well as restricted access to specialized machinery for their production. Currently, the cost of manufacturing bioplastics is still higher than that of conventional plastics, which limits their competitiveness. In this context, environmental regulation emerges as the main driver of raw material substitution, although the associated costs end up being transferred to the final consumer.

The industrial production of bioplastics requires biomass in order to obtain inputs such as starch and cellulose, and this can generate competition with the production of food, feed and bioenergy, an additional challenge in terms of sustainability.

Another relevant challenge is the lack of a specific category that identifies bioplastics in recycling streams. The absence of this differentiation increases the risk of these materials—especially biodegradable ones—mixing with other recyclable plastics and contaminating recycling streams. In Europe and the United States, recyclers' associations have warned about this problem, pointing out that bioplastics can compromise the quality of materials such as PET bottles or flexible films.

In Mexico, regulations promote the production and marketing of biodegradable and compostable bioplastics, considering their shipment to composting plants within the framework of the circular economy. However, the low commercial value of compost and the lack of infrastructure for its processing represent barriers that, if left unaddressed, will limit the efficiency and effectiveness of these initiatives.

9.2 Conclusions Shared with Canada and the United States on Bioplastics Waste Management

In December 2024, the CEC released a bioplastics management study and executive summary for Canada and the United States.[2] Both documents contain a section dedicated to the obstacles that hinder the recycling of bioplastic waste. These barriers bear significant similarities to those identified in Mexico; however, the solutions proposed could only be implemented in some states or municipalities or at the producer level, without neglecting the issues raised in the Findings and Recommendations section of this study.

In Tables 13 and 14 below, the texts in the original English version of the Canada/US study prepared for the CEC are presented in italics. When the content corresponds specifically to the wording applicable to Mexico, it is shown in normal font and bold type.

In some cases, barriers to circularity are due to multiple possible causes, each with its own suggested solutions and corresponding policy actions. For ease of understanding, the tables below are structured with separate cells and color-coded to visually distinguish the information: in red are the two columns on the left, which describe the challenges and barriers to circularity, and in green are the two columns on the right, which contain suggested solutions.

At the top of each table, the flags of the countries to which the information applies are included. It should be noted that there is some overlap and repetition in the tables, as barriers to circularity may have more than one cause, and policy measures may function as a solution to more than one identified challenge. For example, the development and dissemination of guidelines for the appropriate application of alternatives to bio-based or biodegradable plastics is mentioned, in order to obtain the best possible environmental and circular outcome. This measure can simultaneously respond to obstacles at the stages of *procurement*, *product design* and *formulation of bans on single-use plastics.*

[2] The executive summary in Spanish and the full text of the technical study in English are available at: <www.cec.org/es/publications/estudio-de-oportunidades-en-relacion-con-el-manejo-de-residuos-de-bioplasticos-en-canada-y-estados-unidos/> and <www.cec.org/publications/milestone-study-on-bioplastics-waste-management-in-the-us-canada/>.

Table 13. Bioplastics – Shared conclusions with Canada and the United States

Barrier to circularity	Possible cause	Suggested solution	Actions for policymakers
Biodegradable and bio-based plastic products contain misleading claims: ***Products are misleadingly marketed or labeled, both in terms of "sustainable," "eco-friendly" or "green" claims and in terms of disposal and treatment (recyclable or compostable).***	*Misleading claims are neither prohibited nor restricted:* ***There are no national policies prohibiting or limiting the use of misleading claims (e.g., misleadingly claiming the ability to biodegrade) on plastic products.***	***Define federal labeling standards for bio-based, compostable plastics on an industrial or household scale.*** ***Mexico City has a local technical standard that establishes labeling for compostable and biodegradable products. In this sense, it will be convenient to analyze the homologation of logos and labels.***	***Regulate the use of environmental labels and claims. Prohibit the use of misleading labels or claims, allowing only those that accurately state "bio-based," "compostable in industrial facilities" or "compostable at home."*** ***Consider restricting or prohibiting the use of labels such as "biodegradable in nature, soil or marine environment" in the absence of reliable international standards for verification.*** ***Based on the best available scientific information, formulate and apply compostability and recyclability assessment criteria and methodologies for labeling bio-based and biodegradable (via composting or recycling) products.***

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Barrier to circularity	Possible cause	Suggested solution	Actions for policymakers
	Lack of explicit guidance to policy makers on sustainable alternatives: ***Confusion and lack of awareness persists among public policy makers regarding the end-of-life management requirements for bioplastic materials, as well as the upstream and downstream management challenges and associated environmental impacts, particularly for biodegradable plastics.*** *When there are life cycle analyses (LCA) on bio-based and biodegradable plastics applied to relevant products, the results may show significant environmental impacts. However, these results are highly dependent on the boundaries and scope of the study, the availability and quality of data, as well as the assumptions used in the LCA model (e.g., raw material type, end-of-life treatment, biodegradation rates) (Walker and Rothman, 2020). This variability makes it difficult to make conclusive recommendations on the preference of one bio-based and compostable plastic over another, or of one group of bioplastics over conventional plastics (Van Roijen and Miller, 2022).*	***Conduct additional research to identify the types of products and applications where bio-based and compostable plastics are viable as alternatives to conventional plastics, and that generate the greatest added value throughout their life cycle, considering environmental benefits, circularity potential and material use efficiency.***	***Encourage inter-agency collaboration with the aim of allocating funds for research on the applicability and feasibility of bio-based and compostable plastics in various types of products. These investigations should consider not only the performance requirements of the products (e.g., their useful life), but also the production systems involved, waste management contexts, consumer behavior and environmental impacts at the early and late stages of the life cycle of the materials in the relevant applications.*** ***Also, allocate resources for country-specific research and life-cycle analysis of bio-based and compostable polymers in a variety of relevant product applications.***

Barrier to circularity	Possible cause	Suggested solution	Actions for policymakers
Limited data availability in Canada, the United States and Mexico: *In these three countries, available and accessible information on the production, consumption and end-of-life treatment of biodegradable and bio-based plastics, as well as on the processing capacities of facilities, is limited. This gap implies the absence of detailed data on the volumes of different materials in circulation, those entering waste streams or escaping into the environment, as well as on material flows within waste management systems, including how they are finally processed.*	*Bioplastics are made up of relatively new groups of materials, which constitute a small fraction compared to the total waste generated. Currently, in Canada and the United States, there are no requirements or incentives for reporting data related to their production, use or disposal.* ***In Mexico, Mexico City is the only state that requires the registration of compostable products for their commercialization, as well as the submission of semiannual reports.*** *The implementation of reuse systems is still far from being a policy priority:* *In many cases, bans on single-use plastics do not encourage reuse or refill schemes, but rather incentivize the transition to equally disposable alternatives, which only perpetuates the consumption of single-use products and limits progress towards a circular economy.*	*Conduct consolidated research on the environmental impact of bio-based and compostable plastics compared to conventional plastics, considering all waste management contexts.*	*Compile and synthesize available research on the environmental impact of bio-based and compostable plastics in relevant product applications, production scenarios and waste management contexts. The main objective is to prepare comprehensive reports that identify the scenarios in which bioplastics are more likely to generate environmental benefits compared to conventional plastics, considering the particularities of each country.* *As part of this action, gaps in current knowledge should be identified in order to detect opportunities for additional research and to strategically guide the allocation of resources and funding for new studies.*
		To provide tools that equip policy makers with the knowledge necessary to incorporate bio-based and compostable plastics in the most effective and least harmful way into single-use plastics policies.	*Based on available scientific data, develop guidelines for policy makers on the different types of bioplastic materials, their potential environmental impact and the opportunities and challenges associated with their production, use and end-of-life management.* *These guidelines could be aimed at state, provincial and municipal governments that have implemented bans on single-use plastics, and presented in the form of a hierarchical toolkit that identifies the most beneficial product applications by material group.* *Such guidance would enable state, provincial and local authorities to recommend truly sustainable material alternatives*

Barrier to circularity	Possible cause	Suggested solution	Actions for policymakers
	Lack of clear guidelines for policy makers on sustainable alternatives: *Confusion and lack of awareness and knowledge persists among policy makers regarding the end-of-life management requirements for bioplastic materials, as well as the challenges associated with their upstream and downstream management and the environmental impacts they generate, particularly for biodegradable plastics (Walker and Rothman, 2020).* *This variability makes it difficult to make conclusive recommendations on the preference of one bio-based and compostable plastic over another, or of a group of bioplastic materials over conventional plastics (Van Roijen and Miller, 2022).* ***The implementation of reuse systems is far from being a policy priority.***		*in cases where reuse is not feasible. Any resulting guidance should emphasize that all biodegradable plastic products should be certified compostable to a recognized standard to ensure their treatment and processing in industrial composting facilities or home composting systems.*
		To move towards a truly circular economy, it is essential to replace single-use products with reuse or refill systems wherever possible, either through regulatory mandates or through incentives targeted at companies. *In many single-use plastic product applications (e.g., grocery bags) reusable alternatives are often preferable to options made from single-use bioplastic materials. However, it is necessary to conduct life cycle analyses (LCA) to determine, for each specific application, whether reusable or single-use bioplastics generate a lower environmental impact.*	*States and provinces in Canada, the United States and Mexico should consider implementing reuse systems and establishing refill quotas, particularly for food service utensils in on-site consumption environments. However, a federal mandate would be ideal, as it would avoid policy fragmentation among jurisdictions and ensure a uniform approach.* **In the case of Mexico, it is essential to ensure that the resources recovered are channeled as a priority to the same sector, in order to strengthen the system and promote the growth of the infrastructure needed to manage these materials.**

Barrier to circularity	Possible cause	Suggested solution	Actions for policymakers
Lack of clarity regarding the inclusion of bio-based and biodegradable plastics in bans on single-use plastics: *At the local and state/provincial level, policies are vague as to whether bio-based and biodegradable plastics are covered by bans on single-use plastics. In some cases, legislation suggests that bio-based and certified compostable plastics be considered as permitted alternatives to conventional single-use plastics.* *The lack of clarity and, at times, the fragmentation of national policies generates confusion among companies that use single-use plastics, making it difficult to identify truly sustainable alternatives and running the risk of perpetuating the consumption of disposable products.*	***Lack of explicit guidance for policy makers on sustainable alternatives:*** *Confusion and lack of awareness and knowledge persists among policy makers regarding the end-of-life management requirements for bioplastics, as well as the challenges associated with their upstream and downstream management and the environmental impacts they generate, especially in the case of biodegradable plastics.* *When there are life cycle analyses (LCA) on bio-based and biodegradable plastics applied to relevant products, the results may show significant environmental impacts. However, these results are highly dependent on the boundaries and scope of the study, the availability and quality of data, as well as the assumptions used in the LCA model (e.g., raw material type, end-of-life treatment, and biodegradation rates)*	*To move towards a truly circular economy, it is essential to replace single-use products with reuse or recharge systems wherever possible, either through regulatory mandates or through incentives targeted at companies.* *In many single-use plastic product applications (e.g., grocery bags) reusable alternatives are often preferable to options made from single-use bioplastic materials. However, it is necessary to conduct life cycle analyses (LCA) to determine, for each specific application, whether reusable or single-use bioplastics generate a lower environmental impact.* *Business owners and managers should be made aware of the benefits of implementing reuse and refill systems, and accessible tools and resources should be made available to facilitate the transition from single-use schemes to models based on reuse and refill.*	*Incentivize the establishment of reuse and refilling systems through pilot schemes and the allocation of federal funds or grants. These grants can be used for reuse and refilling projects developed in collaboration with industry associations, such as food and beverage associations.* *At the state or provincial level, consider implementing tax incentives for companies that adopt reuse and landfill systems.* *In Canada and the United States, single-use plastics tend to be supplied by local suppliers and consumed mainly in shopping malls and street markets in urban areas (e.g., by street food vendors) rather than in table-service restaurants. In these cases, state and local governments should evaluate the feasibility of funding and testing reusable packaging programs, particularly for take-out food, as well as offering incentives to local vendors, shopping centers and suppliers to encourage their participation in such programs.*

Barrier to circularity	Possible cause	Suggested solution	Actions for policymakers
	(Walker and Rothman, 2020). *This variability makes it difficult to make conclusive recommendations on the preference of one bio-based and compostable plastic over another, or of a group of bioplastic materials over conventional plastics (Van Roijen and Miller, 2022).* ***The implementation of reuse systems is far from being a policy priority.***		

Barrier to circularity	Possible cause	Suggested solution	Actions for policymakers
The single-use plastics policy remains inconsistent at the national level: *Not all U.S. or Mexican states have implemented bans or restrictions on the use and consumption of unnecessary single-use products, including conventional plastic and bio-based and biodegradable plastics. In addition, the promotion of alternative materials varies from jurisdiction to jurisdiction, creating confusion for both businesses and consumers regarding the management of conventional and bioplastic waste plastics.*	***Lack of a national policy restricting or banning single-use plastics:*** *At the national level, there is no federal legal framework that prohibits or restricts the production and consumption of single-use plastic.*	*It is recommended that consideration be given to the introduction of a federal law banning or restricting the production and consumption of conventional plastic and single-use bioplastic products.*	*It is recommended that consideration be given to adopting a federal policy that restricts or bans the use of unnecessary single-use plastics, clearly defining whether bioplastic alternatives are included in the ban and establishing differentiated criteria according to the type of product or application. It is also essential to evaluate not only the material from which the product is made, but also its single-use nature.*
			Similarly, it is suggested that consideration be given to the implementation of tax incentives (e.g., tax credits) for companies that have successfully transitioned from single-use plastics to reuse and refill systems, or to more sustainable material alternatives. Such incentives should take into account both the environmental impacts associated with production (upstream) and those related to end-of-life management (towards the end of life).

Table 14. Biodegradable plastics – Shared conclusions with Canada and the United States

Barrier to circularity	Possible cause	Suggested solution	Actions for policymakers
Lack of infrastructure for recycling recyclable and compostable plastics: *There is no adequate infrastructure to process recyclable and compostable plastics (e.g. PLA).*	***Low market volumes and economies of scale:*** *The low volumes of these recyclable and compostable plastics on the market do not justify, for the time being, the implementation of specific separation and processing systems. In addition, contamination of conventional recycling streams has not yet reached levels that represent a significant problem; for example, PLA can act as a contaminant in PET streams, but only in very low concentrations.*	*As the volume of biodegradable plastics entering the waste stream increases, it will be critical to separate them from conventional plastic recycling streams. To achieve this, it will be necessary to implement appropriate sorting technology in material recovery facilities, and perhaps invest in research and development of new sorting technologies that will allow efficient identification of the different types of biopolymers.*	*Where sorting technology already exists—for example, near infrared (NIR) spectroscopy detection systems to identify PLAs—it is recommended that grants or funding opportunities be offered to enable material recovery plants to install or expand this technology to efficiently remove biodegradable plastic contaminants from recycling streams.*

Barrier to circularity	Possible cause	Suggested solution	Actions for policymakers
Limited access to collection systems that accept plastics of industrial composition: *Accessibility to organic waste collection systems that accept compostable plastics at industrial facilities is limited, which increases the likelihood of these products ending up in sanitary landfills. This situation persists even when consumers discard compostable plastics in recycling streams, as the material is considered a contaminant and, in most cases, is separated and diverted from recycling processes.*	***No, limited or inaccessible selective collection of food waste:*** *There are separate food waste collection schemes, but their coverage is limited or inaccessible to a large part of the population. In addition, where accessible collection programs are available, the acceptance of compostable plastics is low. Only 8 percent of municipal curbside collection programs accept compostable packaging (including, but not limited to, compostable plastics) (GreenBlue 2023).*	*Invest in formal, effective and accessible food waste collection and treatment systems. However, this measure should be justified primarily by its environmental benefits, such as the reduction of emissions associated with food waste and the recovery of nutrients through the production of compost, and not exclusively by the need to process compostable plastics in industrial facilities.*	*Provide opportunities to access federal funds or grants to expand and improve waste processing infrastructure, as well as consider using tax credits to incentivize the creation of new infrastructure.*
			Collaborate with food waste prevention programs and take advantage of existing networks to design and implement organic waste management systems that are accessible to the population, as well as to encourage their active participation.
		Encourage greater producer participation by implementing extended producer responsibility schemes for biodegradable plastics.	*Develop guidelines for states or provinces to implement extended producer responsibility models for biodegradable plastics and set minimum treatment targets for composting to encourage investment in infrastructure. If marketing is allowed, consideration should be given to using ecomodulated fees for natural or marine biodegradable plastics that cannot be reliably tested in compliance with regulations and are not formally treated.*
***Limited capacity for food waste treatment**, which is the main processing route available for compostable plastics in industrial facilities.*	***Insufficient food waste composting infrastructure and limited processing capacity:*** *In the United States, while there is some infrastructure for organic waste treatment, facilities are less likely to process food waste from residential streams.*	*Invest in organic and food waste treatment infrastructure.*	*Provide opportunities to obtain federal funding or grants for infrastructure.*
			Improve access to infrastructure for organic waste management by providing federal subsidies for treatment on agricultural land.

Bibliography

AMB. 2025. Personal communication, virtual meeting of the Mexican Bioplastics Association (Asociación Mexicana de Bioplásticos), 3 June 2025.

Anipac. 2023a. *Anuario Estadístico 2023.* Asociación Nacional de Industrias del Plástico, A.C.

Anipac. 2023b. *4.° Informe del Acuerdo Nacional para la Nueva Economía del Plástico en México. Diciembre 2023.* Asociación Nacional de Industrias del Plástico. <https://anipac.org.mx/wp-content/uploads/2023/12/4to-Informe-AN-VERSION-FINAL.pdf>

ASTM International. 2021. *ASTM D6400-21: Standard specification for labeling of plastics designed to be aerobically composted in municipal or industrial facilities.* ASTM, at: <www.astm.org/d6400-21.html>.

Biodegradable Products Institute. 2023. "Certified compostable products," at: <www.bpiworld.org/> (accessed 11 June 2025).

Brainy Insights, The. 2024. "Bioplastics Market Size by Type (Biodegradable Bioplastics and Non-biodegradable/Biobased Bioplastics), Material (Polylactic Acid (PLA), Polyhydroxyalkanoates (PHA), Starch Blends, Bio-PET (Polyethylene Terephthalate), Bio-PE (Polyethylene) and Others), Application (Packaging, Agriculture, Textiles, Automotive & Transport, Consumer Goods, Electronics and Medical & Healthcare), End-Use Industry (Food & Beverage, Retail, Agriculture, Healthcare, Cosmetics & Personal Care and Automotive), Regions, Global Industry Analysis, Share, Growth, Trends, and Forecast 2025 to 2034." At: <https://www.thebrainyinsights.com/report/bioplastics-market-14729>.

CEC. 2024. *Milestone study on bioplastics waste management in the US & Canada*. Montreal, Canada: Commission for Environmental Cooperation. ISBN 978-2-89700-331-9, xi + 153 pp. <https://www.cec.org/wp-content/uploads/Bioplastics_Full-Study.pdf>

ClimateSort. N.d. "Bioplásticos a base de algas y fermentación bacteriana: soluciones emergentes para una economía circular." ClimateSort, at: <www.climatesort.org>.

Data Bridge Market Research. 2024. "Global biodegradable plastics market size, share and trends analysis report: industry overview and forecast to 2032," at: <www.databridgemarketresearch.com/es/reports/global-biodegradable-plastics-market>.

DIN Certco. 2023. Certification of compostable and biobased plastics ["Certificación de plásticos compostables y de origen biológico"]. DIN Certco, at: <https://www.dincertco.de/din-certco/en/main-navigation/products-and-services/certification-of-products/environmental-field/biobased-products/>.

EEA. 2020). *Biodegradable and compostable plastics — Challenges and opportunities.* European Environment Agency. Briefing. <www.eea.europa.eu/publications/biodegradable-and-compostable-plastics>.

EPA. 1995. *Biodegradability, aerobic aqueous biodegradation (screening test): OPPTS 796.3200*. Office of Prevention, Pesticides and Toxic Substances. United States Environmental Protection Agency.

European Bioplastics 2024. "Bioplastics Market Development Update 2024," at: <https://www.european-bioplastics.org/bioplastics-market-development-update-2024/>.

European Committee for Standardization. 2002. *EN 13432:* Requirements for packaging recoverable through composting and biodegradation. European Committee for Standardization, at: <www.cen.eu/>.

Flores, A., F. Loutfi, M. de Lourdes González, and P. Alarcón. 2024. Situación de las políticas sobre economía circular en México. Working paper. WRI México, Mexico City, at: <https://doi.org/10.46830/wriwp.20.00153>.

Flores, L. 2023. "¿Bioplástico, hacia dónde va el mercado?" Tecnología del Plástico, at: <www.tecnologiadelplastico.com/>.

Ghasemlou, M., C.J. Barrow, and B. Adhikari. 2024. The future of bioplastics in food packaging: An industrial perspective. *Food Packaging and Shelf Life* No. 43, Art. 101279.

Global Growth Insights. 2024. "Tamaño del mercado de bioplásticos." Accessed 11 June 2025, at: <www.globalgrowthinsights.com/es/market-reports/bioplastics-market-100768>.

González López, M.E., S.D.J. Calva Estrada, M.S. Gradilla Hernández, and P. Barajas Álvarez. 2023. Current trends in biopolymers for food packaging: A review. *Frontiers in Sustainable Food Systems* No. 7, Art. 1225371, at: <https://doi.org/10.3389/fsufs.2023.1225371>.

Government of the State of Aguascalientes. 2024. "Ley de Protección Ambiental para el Estado de Aguascalientes 2000," at: <https://eservicios2.aguascalientes.gob.mx/NormatecaAdministrador/archivos/EDO-18-50.pdf>.

Government of the State of Baja California. 2021. Ley para la Prevención, Gestión Integral y Economía Circular de los Residuos del Estado de Baja California. *Periódico Oficial del Estado de Baja California*, at: <www.congresobc.gob.mx/Documentos/ProcesoParlamentario/Leyes/TOMO_VII/20210326_LEYRESIDUOS.PDF>.

Government of the State of Baja California Sur. 1991. Ley de Equilibrio Ecológico y Protección del Ambiente del Estado de Baja California Sur. *Periódico Oficial del Estado de Baja California Sur*. Last amendment published 12 December 2018, at: <www.cbcs.gob.mx/index.php/cmply/1508-ley-proteccion-ambiente-bcs>.

Government of the State of Campeche. 2019. Ley para la Gestión Integral de los Residuos Sólidos Urbanos, de Manejo Especial y Peligrosos del Estado de Campeche. *Periódico Oficial del Estado de Campeche*. Last amendment published 1 July 2022, at: <https://legislacion.congresocam.gob.mx/index.php/etiquetas-x-materia/117-ley-para-la-gestion-integral-de-los-residuos-solidos-urbanos-de-manejo-especial/file>.

Government of the State of Chiapas. 2019. Ley de Residuos Sólidos del Estado de Chiapas. *Periódico Oficial del Estado de Chiapas*, No. 039. Newly created text published 19 June 2019, at: <https://consejeriajuridica.chiapas.gob.mx/Marco_Juridico/Leyes/pdf/LEY%20DE%20RESIDUOS%20SOLIDOS%20PARA%20EL%20ESTADO%20DE%20CHIAPAS%20Y%20SUS%20MUNICIPIOS.pdf>.

Government of the State of Chiapas. 2021. Ley Ambiental para el Estado de Chiapas. *Periódico Oficial del Estado de Chiapas*. Last amendment published in 2019, at: <https://consejeriajuridica.chiapas.gob.mx/Marco_Juridico/Leyes/pdf/LEY%20AMBIENTAL%20PARA%20EL%20ESTADO%20DE%20CHIAPAS.pdf>.

Government of the State of Chihuahua. 2014. Ley para la Prevención y Gestión Integral de los Residuos del Estado de Chihuahua. *Periódico Oficial del Estado de Chihuahua* No. 50, 21 June 2014 (in effect as of 6 March 2015), at: <www.congresochihuahua2.gob.mx/biblioteca/leyes/archivosLeyes/1084.pdf>.

Government of the State of Coahuila de Zaragoza. 2005. Ley para la Prevención y Gestión Integral de Residuos del Estado de Coahuila de Zaragoza. *Periódico Oficial del Estado de Coahuila de Zaragoza*. Last amendment published on 24 July 2020, at: <www.congresocoahuila.gob.mx/transparencia/03/Leyes_Coahuila/coa136.pdf>.

Government of the State of Colima. 2006. Ley de Residuos Sólidos del Estado de Colima. *Periódico Oficial del Estado de Colima*, No. 40. Last amendment: Decree 488, 2 June 2018, at: <https://congresocol.gob.mx/web/Sistema/uploads/LegislacionEstatal/LeyesEstatales/residuos_solidos_02jun2018.pdf>.

Government of the State of Durango. 2007. Ley para la Prevención y Gestión Integral de los Residuos del Estado de Durango. *Periódico Oficial del Estado de Durango* No. 4. Decree 390, 12 July 2007, at: <http://congresodurango.gob.mx/Archivos/legislacion/LEY%20PARA%20LA%20PREVENCION%20Y%20GESTION%20DE%20RESIDUOS.pdf>.

Government of the State of Guanajuato. 2005. Ley para la Gestión Integral de Residuos del Estado de Guanajuato. *Periódico Oficial del Estado de Guanajuato*, at: <www.congresogto.gob.mx/leyes/ley-para-la-gestion-integral-de-residuos-del-estado-y-los-municipios-de-guanajuato>.

Government of the State of Guerrero. 2008. Ley de Aprovechamiento y Gestión Integral de los Residuos del Estado de Guerrero. *Periódico Oficial del Estado de Guerrero* No. 27. Last amendment published on 2 April 2019, at: <www.guerrero.gob.mx/wp-content/uploads/2022/02/L593AGIREG.pdf>.

Government of the State of Guerrero. 2009. Ley número 878 del Equilibrio Ecológico y la Protección al Ambiente del Estado de Guerrero. *Periódico Oficial del Gobierno del Estado de Guerrero*. Last amendment published on 2 April 2019, at: <http://marcojuridico.morelos.gob.mx/archivos/leyes/pdf/LAMBIENTEM.pdf> and <https://congresogro.gob.mx/legislacion/ordinarias/ARCHI/LEY-DEL-EQUILIBRIO-ECOLOGICO-Y-LA-PROTECCION-AL-AMBIENTE-DEL-ESTADO-DE-GUERRERO-878-2021-03-10.pdf>.

Government of the State of Hidalgo. 2011. Ley de Prevención y Gestión Integral de Residuos del Estado de Hidalgo. *Periódico Oficial del Estado de Hidalgo*. Last amendment published on 20 August 2024, at: <www.congreso-hidalgo.gob.mx/biblioteca_legislativa/leyes_cintillo/Ley%20de%20Prevencion%20y%20Gestion%20Integral%20de%20Residuos%20del%20Estado.pdf>.

Government of the State of Jalisco. 2007. Ley de Gestión Integral de los Residuos del Estado de Jalisco. *Periódico Oficial del Estado de Jalisco*, at: <https://info.jalisco.gob.mx/sites/default/files/leyes/ley_de_gestion_integral_de_los_residuos_del_estado_de_jalisco.pdf>.

Government of the Estado de México. 2006. Código para la Biodiversidad del Estado de México. *Gaceta del Gobierno*. Last amendment published on 5 April 2024, at: <https://legislacion.edomex.gob.mx/node/915>.

Government of the State of Michoacán de Ocampo. 2010. Ley para la Prevención y Gestión Integral de Residuos del Estado de Michoacán de Ocampo. *Periódico Oficial del Estado de Michoacán de Ocampo* Vol. CLXVI, No. 31, twenty-eighth section. Last amendment published on 29 Decembe 2016, at: <http://congresomich.gob.mx/file/LEY-PARA-LA-PREVENCI%C3%93N-Y-GESTI%C3%93N-INTEGRAL-DE-RESIDUOS-EN-EL-ESTADO-REF-29-DIC-2016.pdf>.

Government of the State of Morelos. 2007. Ley de Residuos Sólidos y de Economía Circular del Estado de Morelos. *Periódico Oficial del Estado de Morelos*. Last amendment published on 15 February 2023, at: <www.marcojuridico.morelos.gob.mx/archivos/leyes/pdf/LRESIDUOSEM.pdf>.

Government of the State of Nayarit. 2001. Ley de Equilibrio Ecológico y Protección al Ambiente del Estado de Nayarit. *Periódico Oficial del Estado de Nayarit*. Last amendment published on 7 June 2021, at: <https://congresonayarit.gob.mx/wp-content/uploads/QUE_HACEMOS/LEGISLACION_ESTATAL/leyes/equilibrio_ecologico_y_proteccion_al_ambiente_del_estado_de_nayarit_ley_estatal_del.pdf>.

Government of the State of Nuevo León. 2019. Ley de Residuos Sólidos del Estado de Nuevo León. *Periódico Oficial del Estado de Nuevo León*, at: <www.hcnl.gob.mx/glpmc/10715d475b0b22b1abf776e61ad46e0b5c466bea.pdf>.

Government of the State of Oaxaca. 2019. Ley para la Prevención y Gestión Integral de Residuos del Estado de Oaxaca. *Periódico Oficial del Estado de Oaxaca* No. 16, twenty-eighth section. Last amendment, Decree 1228, approved on 4 April 2023 and published on 22 April 2023, at: <www.congresooaxaca.gob.mx/docs65.congresooaxaca.gob.mx/legislacion_estatal/Ley_para_la_Prevencion_y_Gestion_Integral_de_los_Residuos_Solidos_%28Ref_dto_1228_LXV_Legis_4_abr_2023_PO_16_28a_secc_22_abr_2023%29.pdf>.

Government of the State of Puebla. 2006. Ley para la Prevención y Gestión Integral de los Residuos Sólidos Urbanos y de Manejo Especial del Estado de Puebla. *Periódico Oficial del Estado de Puebla*, at: <https://ojp.puebla.gob.mx/legislacion-del-estado/item/229-ley-para-la-prevencion-y-gestion-integral-de-los-residuos-solidos-urbanos-y-de-manejo-especial-para-el-estado-de-puebla>.

Government of the State of Querétaro. 2021. Ley para la Prevención, Gestión Integral y Economía Circular de los Residuos del Estado de Querétaro. *Periódico Oficial del Estado de Querétaro*, at: <www.ceaqueretaro.gob.mx/wp-content/uploads/2022/07/Ley-para-la-Prevención-Gestión-Integral-y-Economía-Circular-de-los-Residuos-del-Estado-de-Querétaro.pdf>.

Government of the State of Quintana Roo. 2018. Ley de Equilibrio Ecológico y la Protección al Ambiente del Estado de Quintana Roo. *Periódico Oficial del Estado de Quintana Roo*. Last amendment published on 16 August 2018, at: <https://documentos.congresoqroo.gob.mx/leyes/L22-XV-16082018-741.pdf>.

Government of the State of Quintana Roo. 2019. Ley para la Prevención, Gestión Integral y Economía Circular de los Residuos del Estado de Quintana Roo. *Periódico Oficial del Estado de Quintana Roo*. Last amendment published on 22 December 2023, at: <https://documentos.congresoqroo.gob.mx/leyes/L199-XVII-20231222-L1720231222200.pdf>.

Government of the State of San Luis Potosí. 1999. Ley Ambiental del Estado de San Luis Potosí. *Periódico Oficial del Estado de San Luis Potosí*. Last amendment published on 5 September 2024, at: <https://congresosanluis.gob.mx/sites/default/files/unpload/legislacion/leyes/2025/07/Ley%20Ambiental%20del%20Estado%20de%20san%20Luis%20Potosi%20%28al%2021%20de%20marzo%202025%29.pdf>.

Government of the State of Sinaloa. 2018. "Ley de Residuos del Estado de Sinaloa." Last amendment published on 21 February 2020, at: <https://legislacion.scjn.gob.mx/Buscador/Paginas/wfArticuladoFast.aspx?q=b/EcoMjefuFeB6DOaNOimOZAwIUyEB9JiuiO/vRdtrvswYL80PEbJHtgLEM+XsBXhYyg+VVvDJsxBVz9JvzHKA==>.

Government of the State of Sonora. 2008. Ley del Equilibrio Ecológico y Protección al Ambiente del Estado de Sonora. *Periódico Oficial del Estado de Sonora*, at: <https://transparencia.heroicanogales.gob.mx/storage/laws/rd1NlTXrWP4SDEf0lOtGb0cilBB4dAGP2GisBpxC.pdf>.

Government of the State of Tabasco. 2012. Ley para la Prevención y Gestión Integral de los Residuos del Estado de Tabasco. *Periódico Oficial del Estado de Tabasco*. Last amendment published on 20 May 2023, at: <https://tabasco.gob.mx/leyes/descargar/0/433>.

Government of the State of Tamaulipas. 2008. Código para el Desarrollo Sustentable del Estado de Tamaulipas. *Periódico Oficial del Estado de Tamaulipas.* Last amendment published on 27 November 2018, at: <https://po.tamaulipas.gob.mx/wp-content/uploads/2021/10/Codigo_Desarrollo_Sustentable-1.pdf>.

Government of the State of Tlaxcala. N.d. Ley de Residuos del Estado de Tlaxcala. *Periódico Oficial del Estado de Tlaxcala*, extraordinary issue, 15 June 2023, at: <https://sfp.tlaxcala.gob.mx/pdf/normateca/LEY%20DE%20RESIDUOS%20DEL%20ESTADO%20DE%20TLAXCALA.pdf>.

Government of the State of Zacatecas. 2010. Ley de Residuos Sólidos del Estado de Zacatecas. *Periódico Oficial del Estado de Zacatecas.*Last amendment published on 23 March 2013, at: <www.congresozac.gob.mx/f/elemento&cual=156POGEG>.

Grand View Horizon. N.d. "Bioplastics-market/Mexico," at <www.grandviewresearch.com/horizon/outlook/bioplastics-market/mexico> (accessed June 2025).

Hernández, L. 2022. "Polybion construye primera planta de biofabricación de celulosa en el mundo." Mexico Industry, at: <https://mexicoindustry.com/noticia/polybion-construye-primera-planta-de-biofabricacion-de-celulosa-en-el-mundo> (accessed 19 June 2025).

IfBB. 2024. "Global production capacities of bioplastics by material type". Institute for Bioplastics and Biocomposites, Hochschule Hannover. <https://www.ifbb-hannover.de>.

INECC. 2020. *Panorama general de las tecnologías del reciclaje de plásticos en México y en el mundo.Diciembre 2020.* Instituto Nacional de Ecología y Cambio Climático, Secretaría de Medio Ambiente y Recursos Naturales, at: <https://pdf4pro.com/view/panorama-general-de-las-tecnolog-237-as-de-reciclaje-de-gob-77726b.html>.

INEGI. 2023. *National Census of Municipal Governments (CNGMD) and Territorial Demarcations of Mexico City, 2023.* Instituto Nacional de Estadística y Geografía. <https://en.www.inegi.org.mx/programas/cngmd/2023/>.

ISO. 2021. ISO 17088:2021, Plastics — Organic recycling — Specifications for compostable plastics. International Organization for Standardization, at: <www.iso.org/en/standard/74994.html>.

ISO. N.d. "ISO 14024:2018 (en) Environmental labels and declarations — Type I environmental labelling — Principles and procedures," at: <www.iso.org/obp/ui/en/#iso:std:iso:14024:ed-2:v1:en>.

Juyal, V. N.d. Global biodegradable plastics market size, share and trends analysis report: Industry overview and forecast to 2032. [Trans.] Data Bridge Market Research, at: <www.databridgemarketresearch.com/es/reports/global-biodegradable-plastics-market>.

Lifeder. 2023. *Bioplastics*, 4 October 2023, at: <www.lifeder.com/bioplasticos/>.

Marcolite. N.d. At: <https://marcolite.com/es-mx/>.

Normex. 2025. "Certificación de biodegradabilidad," at: <https://normex.com.mx/certificacion-de-producto-3/>.

NYCE. 2019. "Pruebas de laboratorio y certificación compostable." Grupo NYCE, at: <www.nyce.org.mx/>.

Plastics Europe (2023), "Plastics Europe launches Plastics – The fast facts 2023," at: <https://plasticseurope.org/media/plastics-europe-launches-the-plastics-the-fast-facts-2023/>.

POT. 2008. "Código para el Desarrollo Sustentable del Estado de Tamaulipas." *Periódico Oficial del Estado de Tamaulipas*. Last amendment published 27 November 2018.

POS. 2018. "Ley de Residuos del Estado de Sinaloa." *Periódico Oficial del Estado de Sinaloa*. Last amendment published 21 February 2020.

POTl. N.d. "Ley de Residuos del Estado de Tlaxcala." *Periódico Oficial del Estado de Tlaxcala*, extraordinary issue, 15 June 2023.

POC. 2021. "Ley Ambiental para el Estado de Chiapas." *Periódico Oficial del Estado de Chiapas*. Last amendment published in 2019, at: <https://consejeriajuridica.chiapas.gob.mx/Marco_Juridico/Leyes/pdf/LEY%20AMBIENTAL%20PARA%20EL%20ESTADO%20DE%20CHIAPAS.pdf>.

POE. 1991. "Ley de Equilibrio Ecológico y Protección del Ambiente del Estado de Baja California Sur." *Periódico Oficial del Estado de Baja California Sur*. Last amendment published 12 December 2018.

POE. 1999. "Ley Ambiental del Estado de San Luis Potosí." *Periódico Oficial del Estado de San Luis Potosí*. Last amendment published 5 September 2024.

POE. 2001. "Ley de Equilibrio Ecológico y Protección al Ambiente del Estado de Nayarit." *Periódico Oficial del Estado de Nayarit*. Last amendment published 7 June 2021.

POE. 2005a. "Ley para la Gestión Integral de Residuos del Estado de Guanajuato." *Periódico Oficial del Estado de Guanajuato*.

POE. 2005b. "Ley para la Prevención y Gestión Integral de Residuos del Estado de Coahuila de Zaragoza." *Periódico Oficial del Estado de Coahuila de Zaragoza*. Last amendment published 24 July 2020.

POE. 2006a. "Ley de Residuos Sólidos del Estado de Colima." *Periódico Oficial del Estado de Colima*. Decree 488, p.o. 40. Last amendment published 2 June 2018.

POE. 2006b. "Ley para la Prevención y Gestión Integral de los Residuos Sólidos Urbanos y de Manejo Especial del Estado de Puebla." *Periódico Oficial del Estado de Puebla*.

POE. 2007a. "Ley de Gestión Integral de los Residuos del Estado de Jalisco." *Periódico Oficial del Estado de Jalisco*.

POE. 2007b. "Ley de Residuos Sólidos y de Economía Circular del Estado de Morelos." *Periódico Oficial del Estado de Morelos*. Last amendment published 15 February 2023.

POE. 2007c. "Ley para la Prevención y Gestión Integral de los Residuos del Estado de Durango." *Periódico Oficial del Estado de Durango*. Decree 390, 63 Legislature, published 12 July 2007.

POE. 2008a. "Ley de Aprovechamiento y Gestión Integral de los Residuos del Estado de Guerrero." *Periódico Oficial del Estado de Guerrero* No. 27, Scope 1. Last amendment published 2 April 2019.

POE. 2008b. "Ley del Equilibrio Ecológico y Protección al Ambiente del Estado de Sonora." *Periódico Oficial del Estado de Sonora*.

POE. 2010. "Ley para la Prevención y Gestión Integral de Residuos del Estado de Michoacán de Ocampo." *Periódico Oficial del Estado de Sonora* volume CLXVI, No. 31, twenty-eighth section. Last amendment published 29 December 2016.

POE. 2011. "Ley de Prevención y Gestión Integral de Residuos del Estado de Hidalgo." *Periódico Oficial del Estado de Hidalgo*. Last amendment published 20 August 2024.

POE. 2012. "Ley para la Prevención y Gestión Integral de los Residuos del Estado de Tabasco." *Periódico Oficial del Estado de Tabasco*.

POE. 2014. "Ley para la Prevención y Gestión Integral de los Residuos del Estado de Chihuahua." *Periódico Oficial del Estado de Chihuahua* No. 50, 21 June 2014 (effective 6 March 2015).

POE. 2019a. "Ley de Residuos Sólidos del Estado de Chiapas." *Periódico Oficial del Estado de Chiapas* No. 039, 19 June 2019.

POE. 2019b. "Ley de Residuos Sólidos del Estado de Nuevo León." *Periódico Oficial del Estado de Nuevo León*.

POE. 2019c. "Ley para La Gestión Integral de los Residuos Sólidos Urbanos, de Manejo Especial y Peligrosos del Estado de Campeche." *Periódico Oficial del Estado de Campeche*. Last amendment published 1 July 2022.

POE. 2019d. "Ley para la Prevención y Gestión Integral de Residuos del Estado de Oaxaca." *Periódico Oficial del Estado de Oaxaca* No. 16. Last amendment, Decree No. 1228, published 22 April 2023.

POE. 2019e. "Ley Para la Prevención, Gestión Integral y Economía Circular de los Residuos del Estado de Quintana Roo." *Periódico Oficial del Estado de Quintana* Roo, last amendment published 22 December 2023.

POE. 2021a. "Ley para la Prevención, Gestión Integral y Economía Circular del Estado de Baja California." *Periódico Oficial del Estado de Baja California* volume CXXVIII, No. 21, section II, 26 March 2021.

POE. 2021b. "Ley para la Prevención, Gestión Integral y Economía Circular de los Residuos del Estado de Querétaro." *Official Gazette of the State of Querétaro*.

POEA. 2024. "Ley de Protección Ambiental para el Estado de Aguascalientes 2000." *Periódico Oficial del Estado de Aguascalientes*, at: <https://eservicios2.aguascalientes.gob.mx/NormatecaAdministrador/archivos/EDO-18-50.pdf>.

POEQR. 2015. "Ley de Equilibrio Ecológico y la Protección al Ambiente del Estado de Quintana Roo." *Periódico Oficial del Estado de Quintana Roo*. Last amendment published 16 August 2018, at: <https://documentos.congresoqroo.gob.mx/leyes/L22-XV-16082018-741.pdf>.

POG. 2010. "Ley de Residuos Sólidos del Estado de Zacatecas." *Periódico Oficial del Estado de Zacatecas*. Last amendment published 23 March 2013.

POGEG. 2009. "Ley Número 878 del Equilibrio Ecológico y la Protección al Ambiente del Estado de Guerrero." *Periódico Oficial del Estado de Guerrero*. Last amendment published 2 April 2019, at: <http://marcojuridico.morelos.gob.mx/archivos/leyes/pdf/LAMBIENTEM.pdf> and <https://congresogro.gob.mx/legislacion/ordinarias/ARCHI/LEY-DEL-EQUILIBRIO-ECOLOGICO-Y-LA-PROTECCION-AL-AMBIENTE-DEL-ESTADO-DE-GUERRERO-878-2021-03-10.pdf>.

POGG. 2006. "Código para la Biodiversidad del Estado de México." *Periódico Oficial del Estado de México*. Last amendment published 5 April 2024.

Ruiz Suárez, L.G., A. Gavilán García, A. Mendoza Cantú, T. Ramírez Muñoz and J.A. Araiza Aguilar. 2022. *Atlas Nacional de Residuos Sólidos Urbanos*. Instituto Nacional de Ecología y Cambio Climático (INECC), p. 311, at: <www.gob.mx/cms/uploads/attachment/file/693803/125_2022_Atlas_Nacional_Residuos_Solidos.pdf>.

Sánchez, Joselyn. 2025. "Estudiante de la UAEH desarrolla bioplásticos de lirio acuático; Analizan su uso en la presa Endhó." *La Jornada Hidalgo*, 15 May 2025, at: <https://lajornadahidalgo.com/estudiante-de-la-uaeh-desarrolla-bioplasticos-de-lirio-acuatico-analizan-su-uso-en-la-presa-endho/> (accessed 19 June 2025).Secretaría de Economía. 2018. "NMX-AA-180-SCFI-2018: Compostaje de residuos orgánicos." *Diario Oficial de la Federación*, at: <www.dof.gob.mx/nota_detalle.php?codigo=5391337&fecha=07/05/2015>.

Secretaría de Economía. 2019. "NMX-E-273-NYCE-2019: Plásticos compostables – Especificaciones y métodos de prueba," at: https://www.nyce.org.mx/>.

Sedema. 2019. "NACDMX-010-AMBT-2019: Norma Ambiental para productos compostables." Secretaría del Medio Ambiente, Mexico City, at: <www.sedema.cdmx.gob.mx/>.

Sedema. 2025. “Convoca Sedema a sumarse a la Evaluación de Circularidad para obtener distintivo.” Press release. Secretaría del Medio Ambiente, Mexico City, 14 March 2025, at: <https://sedema.cdmx.gob.mx/comunicacion/nota/convoca-sedema-sumarse-la-evaluacion-de-circularidad-para-obtener-distintivo#:~:text=El%20Distintivo%20de%20Circularidad%20es,Nivel%202%3A%2090%25%20de%20cumplimiento>.

Semarnat. 1985a. Norma Mexicana NMX-AA-022-1985. Protección al ambiente – Contaminación del suelo – Residuos sólidos municipales – Selección y cuantificación de subproductos. Secretaría de Medio Ambiente y Recursos Naturales, at: <https://biblioteca.semarnat.gob.mx/janium/Documentos/Ciga/agenda/DOFsr/NMX-AA-022-1985.pdf>.

Semarnat. 1985b. Norma Mexicana NMX-AA-15-1985. Protección al ambiente – Contaminación del suelo – Residuos sólidos municipales – Muestreo – Método de cuarteo. Secretaría de Medio Ambiente y Recursos Naturales, at: <https://biblioteca.semarnat.gob.mx/janium/Documentos/Ciga/agenda/DOFsr/NMX-AA-015-1985.pdf>.

Semarnat. 1985c. Norma Mexicana NMX-AA-61-1985. Secretaría de Medio Ambiente y Recursos Naturales, at: <http://legismex.mty.itesm.mx/normas/aa/aa061.pdf>.

Semarnat. 2002. “NOM-004-SEMARNAT-2002: Lodos y biosólidos. Límites máximos permisibles de contaminantes.” *Diario Oficial de la Federación*. Secretaría de Medio Ambiente y Recursos Naturales, at: <www.dof.gob.mx/nota_detalle.php?codigo=691939&fecha=15/08/2003>.

Semarnat. 2003. “NOM-083-SEMARNAT-2003: Especificaciones ambientales para disposición final de residuos. Secretaría de Medio Ambiente y Recursos Naturales,” at: <https://www.profepa.gob.mx/innovaportal/file/1306/1/nom-083-semarnat-2003.pdf>.

Semarnat. 2013. *Ley General para la Prevención y Gestión Integral de los Residuos*. Secretaría de Medio Ambiente y Recursos Naturales, at: <www.diputados.gob.mx/LeyesBiblio/pdf/LGPGIR.pdf>.

Semarnat. 2020. *Panorama general de las tecnologías del reciclaje de plásticos en México y en el mundo*. Secretaría de Medio Ambiente y Recursos Naturales.

Standards Australia. 2006. *Biodegradable plastics – Biodegradable plastics suitable for composting and other microbial treatment* (AS 4736-2006). Standards Australia International.

TÜV Austria. 2023. “OK compost: Home,” and “OK compost: Industrial.” Certification, at: <https://okcert.tuvaustria.com/ok-compost-home-en/> and <https://okcert.tuvaustria.com/ok-compost-industrial-en/>.

UN Comtrade. 2024. United Nations Commodity Trade Statistics Database. <https://comtradeplus.un.org>.

UNEP. 2024. *Global waste management outlook 2024 – Beyond an age of waste: turning rubbish into a resource – Executive summary*. Nairobi: United Nations Environment Programme, at: <https://wedocs.unep.org/20.500.11822/44992>.

USDA. 2023. BioPreferred® Program: Product certification. United States Department of Agriculture, at: <www.biopreferred.gov/>.

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