An Overview Bioethanol Production from Agricultural Products

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ABSTRACT

The global trend is shifting towards the adoption of sustainable resources as a viable alternative to fossil fuels. Bioethanol, being one of the foremost sustainable energy sources, holds significant importance due to its ability to be derived from inexpensive raw materials that are commonly found in local surroundings. Bioethanol synthesis from biomass occurs in three stages (first generation, second generation, third generation) based on the specific raw material utilized in the process. The most important steps are pre-treatment, hydrolysis, fermentation and distillation. The three generations have provided sustainable bioethanol, along with the potential to enhance fermentation and processing conditions. This expands the opportunities for researchers to devise new production methods as a substitute for clean energy alternatives. The study primarily examines the techniques for generating bioethanol, with a specific emphasis on the date palm. It investigates the key aspects that influence the production of bioethanol from this source, including scientific economics. Additionally, the study evaluates the yield and productivity of bioethanol based on various operating conditions and the specific type of dates employed.

Keywords: *renewable energy; biofuel; bioethanol production; date palm*

INTRODUCTION

Using more and more conventional fossil fuels is driving up demand for these fuels, which in turn is contributing to climate change through things like greenhouse gas emissions and overall warming. Renewable and sustainable energy sources like biomass, wind, solar, and hydroelectric power have been the focus of many efforts to address global energy demand, fossil fuel consumption, carbon dioxide emissions, and the role of bio-resources in agriculture[1].

Of the many different alternative energy sources, biofuels stand out as particularly noteworthy due to the fact that they are generally compatible with the liquid fuels that are currently used for transportation. In comparison to fuels derived from fossils, it is considered to be a viable alternative. Fossil fuels and fuels derived from fresh biomass have the same ingredients (hydrogen and carbon). However, fossil fuels are considered non-renewable due to the lengthy time required for their formation [2]. A consequence of this is that the rate of consumption is higher than the pace of production. The development of biofuels is of great interest due to their significant environmentally-friendly potential. Biofuels contribute to a CO2 cycle in combustion and can be easily obtained from common biomass sources. In addition to this, they are biodegradable and contribute to the preservation of the environment. The utilization of crops that are expressly developed for the purpose of producing biofuels is another way in which the production of biofuels helps to strengthen rural economies [3,4]. During the process of photosynthesis, carbon dioxide, which is present in both the atmosphere and the oceans on Earth, is subjected to a chemical reaction that results in the production of sugars. Sugars are the fundamental components of biomass. Solar energy, which is the driving force behind photosynthesis, is stored inside the chemical bonds that are present in the structural components of the plant. When the energy that is stored in the chemical bonds of biomass is released through efficient combustion, the oxygen that is present in the atmosphere mixes with the carbon that is present in plants to form carbon dioxide and water.

Biomass energy production can be achieved through a variety of methods. One example is biological processing,

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which makes use of processes found in nature to produce fuel in the form of liquid or gas, such as fermentation or anaerobic digestion. Thermochemical processing, on the other hand, encompasses liquefaction, pyrolysis, and gasification processes. Additionally, biomass can also be directly combusted to generate energy [5].
Liquid biofuels like bioethanol can be made from plant biomass that is rich in lignocellulosic waste. Ulva lactuca, sugar beet pulp, and cassava peels are a few examples of this type of biomass. Its high holocellulose content makes it the most appealing renewable energy source for making bioethanol since it is plentiful, cheap, and environmentally friendly. A second-generation feedstock is the name given to this type of energy source [6,7]. This biomass is noteworthy since it cannot be consumed by humans. Consequently, unlike with first-generation biomass crops like sugarcane and maize, there isn't any competition in the food market. Worldwide, more than 90% of plant biomass is lignocellulosic. Every year, the amount exceeds 200 billion tons [8].

BIOENERGY AND BIOMASS

Humanity has relied significantly on traditional bioenergy sources for a long time. The majority of biomass energy—over 85%—is currently wasted as inefficient solid fuels for home appliances like stoves, ovens, and lights. In developing nations, where biomass accounts for almost 95% of total energy consumption, fuelwood and charcoal—classified as traditional bioenergy sources that merely produce heat—are widely used as the principal bioenergy fuels.

The success of contemporary bioenergy is contingent on the development of conversion technologies that are both effective and efficient, and that can be utilized not just in the context of the home but also in the context of industrial and small business settings. There is the possibility that biomass can be transformed into energy carriers that are more convenient to utilize. These energy carriers could include liquid fuels, solid fuels, gaseous fuels, or heat that is gained directly from the manufacturing process [9].

Classification of biofuels

On the basis of the processing that occurs before they are used, biofuels can be classified as either primary or secondary. It is important to note that primary biofuels are consumed in their raw state, which means that the organic matter is utilized in its initial form, just as it is collected. Some examples of primary biofuels include waste materials from forests, pellets, wood chips, agricultural goods, and animal fats. Primary biofuels also include a range of other examples. The majority of the time, they are utilized for the purpose of cooking, heating, meeting the requirements of agriculture, and producing energy in industrial settings that are either little or enormous in scale. In countries with lower incomes, it is common. In common parlance, primary biofuels are sometimes referred to as conventional biomass. Due to the fact that the manufacturing of this biofuel does not need considerable expenditures of resources, the range of applications for this alternative fuel is restricted.In 2013, conventional biomass accounted for around 9% of the total global energy consumption [10].

In the context of biofuels, secondary biofuels are materials that have been processed. The conversion of biomass, which is the primary source of biofuel, is the process that results in their production. Solids, liquids, and gasses are all aspects of secondary biofuels. Secondary biofuels comprise a variety of states of matter. There is a possibility that these biofuels could take the place of fossil fuels in a wider variety of applications, including transportation and industrial processes that carry out high temperatures. Secondary biofuels can be divided into three generations according to the type of raw materials used in their synthesis, the historical sequence in which they have appeared on the global energy market, and the processing technology that is utilized during the final stages of production. First-generation biofuels, second-generation biofuels, and third-generation biofuels are the names given to these three generations of biofuels [11].

Biofuel production generations

In general, there are four primary categories of biofuel generation, which can be distinguished from one another based on the biomass feedstock they use, the constraints they have as a renewable source of energy, and the technological characteristics they possess [12]. Biomass feedstock of biofuels ranges from the edible oils genetic modified algae [13]. According to the feedstock sources, the Initial biofuels is primarily made from sugar, oil and starchy food yields either by directly biodiesel extraction from oil or by traditional fermentation to produce bioethanol from rich starch and sucrose Crops [14].

Initial biofuels

The biomass used to make first-generation biofuels is typically food crops like corn and sugarcane. The first bioethanol was either made from sugar beets, barley, potato waste, or whey [15]. It was a feedstock that was either used or tested. Sugarcane is an optimal source for ethanol production from both an environmental and economic perspective. However, its cultivation is restricted to specific places unpaid to soil and meteorological disorders [16]. Domestic energy security and benefits from reduced CO_2 emissions are two areas where biofuels of the first generation may shine [17]. However, the main problem with these biofuels is that they aren't efficient or sustainable. The capability of production such biofuels is uncertain due to the conflict with food supply [18], which includes concerns about sourcing feedstock, land use, and the potential influence on biodiversity. With an annual production of about 50 billion liters, first-generation biofuels are currently commercially viable. The first generation of biofuels, including biodiesel, biogas, and bioethanol, are categorized according to their compatibility with petroleum-based fuels, their ability to be burnt in current internal combustion engines, and their distribution through existing infrastructure. They can also be incorporated into alternative vehicle technologies that are already in use, such as vehicles powered by natural gas or those that use flexible fuels [19]. Significant production expenses are associated with first-generation biofuels due to competition with food sources. Some crops and food items have become more expensive due to the fast increase in global biofuel production from crops including sugar cane, maize, and oilseeds. So, it's important to look at non-edible biomass as a substitute for food-grade biomass when making biofuels [20].

Biofuels of the second generation

Agricultural and forest trash, white wood chips, and municipal solid waste are all examples of lignocellulosic materials that can be used to make second-generation biofuels. They rely on making use of biomass that is not suitable for human consumption—biomass that is not edible [15]. Second-generation biofuels are grown on marginal land or non-edible crop and forest tree parts. Better technology is needed to efficiently process these sources for bioenergy [21]. Plant biomass cell walls are made of lignin (5-20%), hemicellulose (10-40%), and cellulose (30-50%) [5]. These components' settings vary by author. Cellulose extraction is hard [22]. Second-generation biofuels may resolve the first-generation biofuel controversy [23].

The probability of bioethanol synthesis is affected by the chemical make-up of the organic compounds that are utilized [24]. Agricultural lignocellulosic biomass is the usual source for second-generation liquid biofuels, which are produced by thermochemical or biological processing methods. Unlike first-generation biofuels, which cause food and fuel to compete directly with one another, second-generation biofuels made from inedible feedstock have the benefit of lowering this tension. There is evidence that second-generation biofuels can improve land use efficiency in comparison to first-generation biofuels [25].

According to reference [26], plant biomass cell walls are one of the most abundant renewable resources. Only 2% of biomass is used by humans, despite its abundance. This requires research to see if plant cell walls can be used to make biofuels cheaply. Lignocellulosic materials' cell walls' inability to break down into fermentable sugars is its main drawback. Customizing the wall's composition and structure should be possible by adding substances or altering wall polysaccharide production machines. This adjustment can boost biofuel sugar output. The main problem is that biosynthetic machinery and control research is still in its infancy.

Advanced biofuels of the third generation

Biofuels made from algae biomass are often called third-generation biofuels [27]. The firm advance rate, high starch and lipid joyful, and simplicity of cultivation of microalgae biomass are making it an attractive choice for biofuel generation [28]. Its ability to grow on marginal soils, convert solar energy to chemical energy efficiently, and produce a high surface biomass make it a potential answer to a pressing challenge facing modern civilizations: the development of renewable transportation energy [29]. Algae are considered a distinct category of biomass fuels because of their superior efficiency relative to other biomass sources in terms of both output and input resources. There is no feedstock that can compete with algae when it comes to the quantity and change of fuels that can be created [30].

Those in the know about algae have speculated that harvests of up to 20,000 gallons per acre are possible. However, there are a few downsides to algal biomass. One of them is the high water, phosphorus, and nitrogen requirements for growth, even in wastewater. The stability of biofuels made from algae is also generally lower than that of biofuels made from other sources. Algal oil is more likely to breakdown since it is highly unsaturated, which is particularly true at high temperatures [31].

Plus, there isn't a viable business case for microalgae biofuels just yet. Problems persist in the areas of microalgae strain enhancement and growing technology [32].

BIOETHANOL IS ECO-FRIENDLY AND RENEWABLE

The amount of biofuels produced and used around the world has increased dramatically in recent years. From 2000 to 2007, output climbed to 60.6 billion liters, and in 2019, it reached 162 billion liters. It should be mentioned that bioethanol accounts for about 85% of this total amount [31]. Bioethanol may be derived from a range of inexpensive materials and is recognized as a significant and extensively utilized liquid biofuel globally, particularly in the field of transportation [33]. Depending on feedstock, bioethanol can cut greenhouse gas emissions by 30–85% compared to gasoline [34]. Most biofuels are bioethanol and biodiesel. Bioethanol is made by fermenting carbohydrate-rich biomass, while biodiesel can be made from animal fats, vegetable oils, algae, or recycled cooking greases (Figure 1). Ethanol can be added to gasoline, while biodiesel can be used alone or as a diesel additive [35].

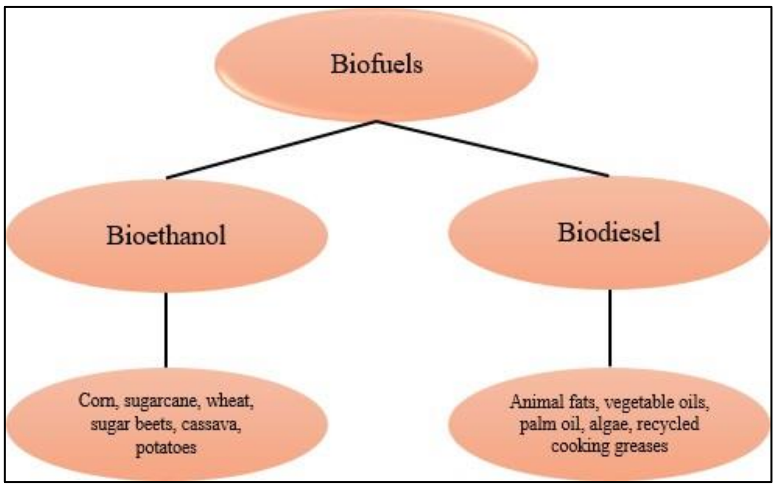

Fig. (1) Biomass used for the production of common biofuels [35].

According to research, ethanol is considered one of the earliest products derived from conventional biotechnology [36].

The use of ethanol as an engine fuel has been around since the Model T period. The idea that plant biomass, which contains abundant sugars and starches, may be economically and efficiently converted into sustainable biofuel was initially recognized by Henry Ford and Alexander Graham Bell. In 2016, the United States held the top position as the largest global producer of ethanol, accounting for about 60% of the world's production. This dominance has continued up to the present day [31].

As well as being utilized in the transportation sector, bioethanol is also utilized in the beverage and pharmaceutical industries, and it is also utilized in the creation of power. Thermal energy, valuable chemicals, and fertilizers are all potential use for the byproducts that are produced during the bioethanol synthesis process. As a result of its wider flammability limitations, higher octane number, greater heat of vaporization, and faster flame speeds, bioethanol has the potential to serve as a replacement for transportation fuels that are derived from fossil fuel supplies. These characteristics make it possible to have a shorter burn period, a higher compression ratio, and a leaner burn engine, which ultimately results in a theoretical efficiency gain over gasoline in an internal combustion engine (Balat, 2007; Rozenfelde et al., 2017).

Blending ethanol with gasoline improves transportation efficiency. It improves automotive fuel combustion, lowering unburned hydrocarbons, carbon monoxide, and carcinogens. However, burning ethanol intensifies nitrogen interaction in the atmosphere, increasing nitrogen oxide emissions slightly. Compared to gasoline, ethanol has less sulfur. Ethanol reduces sulfur oxide emissions by lowering petrol sulfur concentration. Sulfur oxide causes acid rain and cancer (Fao.org, 2008).

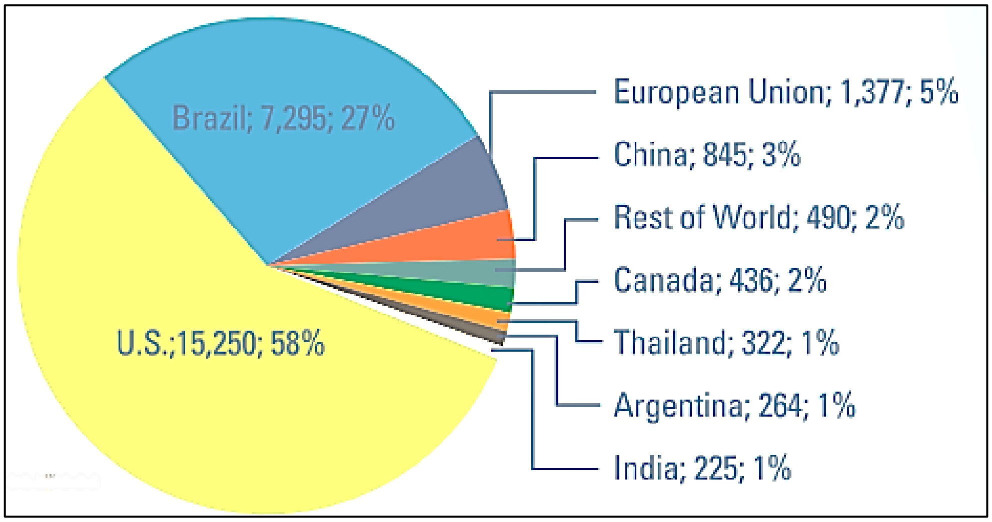

Fig. (2) Global bioethanol production, million gallons in 2016 (Dinneen, 2017) [31].

Making bioethanol from plant-based biomass

Cellulose, hemicellulose, and lignin are the main components of lignocellulosic biomass, although pectin, ash, and extractives are also present, although in smaller amounts. various species of biomass may have various proportions of these components. The cellulose content of hardwoods is higher than that of leaves and wheat straws, which contain more hemicellulose. influences including development stage, age, and environmental influences can cause the ratio of these components to differ within a single plant species. The polymers in question are interconnected inside a hetero-matrix to variable extents and with different relative compositions. Many variables, like the biomass material's kind, species, and origin, influence the strength and make-up of these links [31]. Important factors in determining whether plant species are suitable as energy crops include the amounts of cellulose, hemicellulose, and lignin [5]. For the manufacturing of chemicals, bio-sourced materials, and second-generation biofuels, lignocellulosic materials show great promise as a fossil resource replacement. This option has the advantage of not compromising global food security. Unfortunately, these materials are resistant to enzymatic hydrolysis, which is a major drawback of using them. This resistance is produced by the complex and variable structure of plant cell walls. The issues influencing the resistance of these materials are closely linked and difficult to separate. Chemical factors include lignin, hemicellulose, and acetyl groups, whereas structural parameters include cellulose crystallinity, specific surface area, degree of polymerization, pore size, and volume [37]. To boost productivity and lower production costs, lignocellulosic materials undergo efficient pretreatment, hydrolysis, fermentation, and distillation to separate ethanol from co-products [38].

Step before treatment

Making bioethanol from lignocellulosic plant biomass requires pretreatment. By dissolving the lignin seal, increasing porosity, decreasing crystallinity, and making the hemicellulose soluble, it aims to alter the material's complicated structure. This improves the availability of chemicals or enzymes that hydrolyze cellulose polymers into sugars that can be fermented more easily [39]. The ideal pretreatment would not only be cost-effective but also remove lignin from substrate materials efficiently, prevent carbohydrates from being lost or degraded, produce a high sugar yield, and prevent the production of sugar degradation products [40].

Pretreatment methods for lignocellulosic materials have shifted from chemical and thermal approaches to biological procedures in order to overcome the challenges of employing these materials [41]. On the other hand, when it comes to technology, cost-effectiveness, and reducing inhibitory substance generation, the present pretreatment approaches have not yet produced adequate results [42]. Many different pre-treatment procedures have been proposed and put into practice for lignocellulosic biomass. Figure 3 shows a variety of pretreatment procedures, including physical, chemical, physicochemical, and biological approaches.

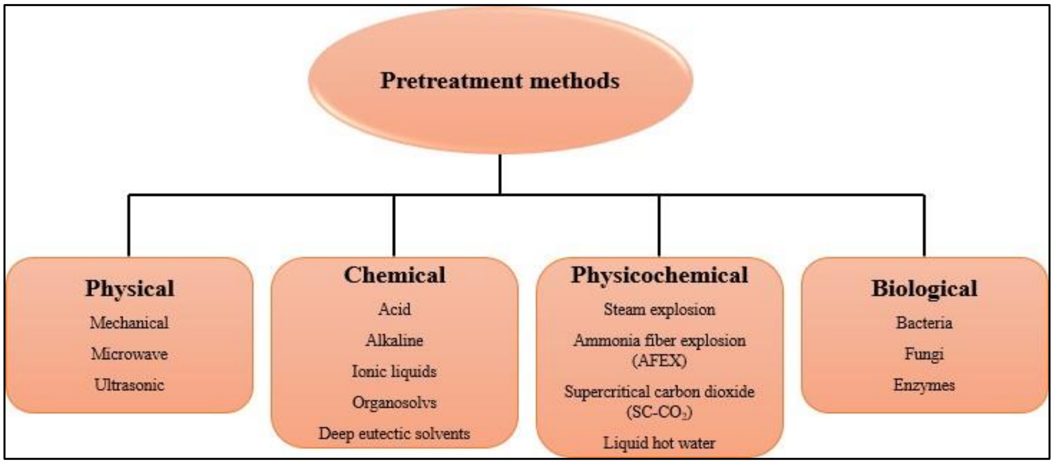

Fig. (3) Different pretreatment processes [42].

Step of hydrolysis

The next step after the preparation process is the hydrolysis process. An addition of water to polymers (like cellulose) breaks them down into monomers (like glucose). This is called hydrolysis. It is a chemical reaction that releases energy by breaking the molecular bonds between two substances. Simple sugars that can be fermented need to be broken down by water. Enzymes and acids (HCl, H2SO4, etc.) are often used to speed up the breakdown of waste. Acid hydrolysis and microbial hydrolysis are the two main types of hydrolysis.

Acid hydrolysis is an extension of acid pretreatment, which is used interchangeably. Acid hydrolysis can be done with liquid or solid acid catalysts or organic acids. Concentrated and dilute liquid acid hydrolysis exist. Each type affects biomass differently. Dilute acid hydrolysis is two-step. Cellulose is converted into sugar, and sugar is converted into chemicals that inhibit fermenting microbes. The process of focused acid hydrolysis, which involves a solution containing around 70% acid, is carried out under low temperatures (37.8oC) and pressure. Nevertheless, when considering both cost factors and the impact on biomass, it is evident that dilute acid is the most favorable option [43]. Braide et al. subjected 50g of corncobs, cornstalk, cornhusk, sugarcane bagasse, and sugarcane bark to a pretreatment process. Each material was treated with 500 ml of 5% H2SO4 at a temperature of 121oC for a duration of 15 minutes. [44] Kanlaya and Jirasak conducted hydrolysis on 1.5% w/v Cassava peel using 0.1 M H2SO4 at a temperature of 135oC, a pressure of 15 lb/inch2, and a duration of 90 minutes. This process resulted in a yield of 66.28% of reducing sugars [45].

A solid (heterogeneous) acid catalyst has recently become more popular for hydrolyzing cellulose into glucose. Metal oxides, supported metals, acid resins, heteropoly acids, carbonaceous acids, magnetic acids, H-form zeolites, functionalized silica, immobilized ionic liquids, and so on are all catalysts in this category (46). In order to selectively hydrolyze cellulose, Ayumu et al. investigated solid acid catalysts, particularly the H-form zeolite catalyst, sulfated catalysts, and sulfonated catalysts. Their research revealed an exceptionally high glucose production from the sulfonated activated-carbon catalyst. The existence of strong acid sites from the SO3H functional groups and hydrophobic planes, along with its outstanding hydrothermal stability and effective catalytic capabilities, were the reasons for this [47].

During enzymatic hydrolysis, Cellulases are a type of enzyme that is utilized to facilitate the breakdown of cellulose by hydrolysis. Nevertheless, there is greater enthusiasm for the utilization of cellulase generated by fungi as opposed to those produced by bacteria. The reason for this is that the majority of bacteria that produce cellulase are anaerobic and have a very slow rate of growth [48].

Step for fermentation

Microbes like bacteria, fungi, and yeast ferment a material into a simpler form. Ethylic fermentation produces ethanol by breaking down simple carbohydrates without oxygen. Consolidated bioprocessing, simultaneous saccharification and fermentation, non-isothermal simultaneous saccharification and fermentation, and simultaneous saccharification, filtration, and fermentation are the main fermentation technologies. Batch, fed-batch, continuous, and solid-state fermentation are also possible [49]. Batch fermentation, commonly known as a (closed system), is the record prevalent and straightforward technique for ethanol production. This technique involves doing fermentation in distinct batches. The substrate is initially put into the fermenter, followed by the addition of microorganisms, which are then left to ferment the substrate [50].

Fermentation in a fed batch: It is an improved version of the batch fermentation process. Substratum, culture medium, and necessary nutrients are added to the fermenter during this procedure. After that, the substrate is fermented by culturing microorganisms and placing them in the fermenter. While fermentation is underway, the feed solution is slowly but surely introduced to the fermenter, keeping the byproducts intact. At the end of every fermentation phase, the products are carefully extracted. One constraint in this technique is the working volume [51].

Fermenting that is just semi-continuous: It is sometimes called repeated fed-batch fermentation or a batch-continuous fermentation hybrid. In this procedure, the feed solution is regularly added to the fermenter and the products are occasionally removed. This process usually requires a fixed volume, therefore spent medium from the fermenter is replaced with fresh feeds at regular intervals. This approach feeds microorganisms new nutrients to prolong their growth. Remove fermentation byproducts periodically to prevent organisms from going dormant or dying, increasing product yield. This method allows longer fermentation, and the cycle is generally not stopped until productivity decreases [52].

Indefinite fermentation: The feed solution is continually fed to the fermenting vessel in continuous loading and extraction, while the products are continuously withdrawn. Since there is less disruption to the cycle than in batch fermentation, the fermentation duration can be extended. Microorganisms are able to continue growing in the fermenting vessel for an extended period of time because of the constant flow of new nutrients and the frequent removal of byproducts that can kill them. As a result, production is increased through this procedure [53].

Step of distillation

For the purpose of separating the various components of a liquid combination, distillation is a technique that involves heating the mixture and then condensing the vapor that is produced as a result of the heating process. The process of distillation is an important method that makes use of the differences in boiling points of the components that are contained within a mixture. Due to the fact that ethanol and water are both soluble in water, distillation is required in order to separate and concentrate the ethanol from the other components that make up the mixture. Due to the presence of strong hydrogen bonds between water and ethanol, it is not possible to attain complete purity by a fundamental distillation process that involves the two components. These bonds cause the water to bond with the ethanol when heated, making it difficult to separate them. Therefore, the full pressure swing distillation process is employed instead [54].

BIOETHANOL PRODUCTION FROM DATE PALM

The date palm is considered a fruit that has been around since ancient times and has many uses. It is grown in different places in the world, it is an important food resource [55]. The use of dates is not limited to being a source of food, but goes beyond that and has some medicinal properties [56], It is recognized as a source of alcoholic beverages around the world [57].

The process of fermenting ethanol from date palms is a biotechnological step that has received great interest due to its potential in producing sustainable biofuels. The process of producing bioethanol is using the natural sugars found in dates and their waste, which are transformed into bioethanol by yeast fungi. [58].

In order to produce bioethanol at a high and sustainable rate a greener alternative to fossil fuels the fermentation process must adhere to certain guidelines and conditions [59]. Fermentation duration, yeast quantity, pH, and temperature are the four most critical variables in bioethanol production [64].

Date palms are a good source of glucose and fructose, two sugars that yeast enzymes can convert into ethanol and carbon dioxide. Yeast strains with broad substrate specificity and direct bioethanol production capabilities are already under development [60].

There has been continuous progress in methods for producing bioethanol from date palms, as hydrothermal treatment has been used to overcome the reluctance of biomass to enzymatic conversion, which facilitates a more efficient fermentation process [61]. In other studies, genetically modified yeast strains are used, designed to grow in different conditions and improve the conversion of sugars into bioethanol at higher rates than conventional strains [60].

Membrane filtration technology is another innovative method that purifies the ethanol produced, ensuring a higher purity level by selectively separating ethanol from other fermentation by-products. These modern techniques not only increase the yield of ethanol from date palm sap but also contribute to making the production process more maintainable and ecologically friendly by reducing waste and energy consumption [62].

The economic impact of bioethanol production on date palm cultivation opens up many agricultural practices and market dynamics. As the request for sustainable and renewable energy sources increases, ethanol, produced from the fermentation of palm sugars, is emerging as a viable alternative. This shift towards ethanol production has enhanced new revenue streams for date palm farmers [63].

The valorization of date palms not only for traditional uses but also as a biofuel resource has augmented their economic value, encouraging investment in cultivation techniques and technologies aimed at enhancing yield and sugar content. However, this shift is not without challenges. It necessitates careful management to balance food and fuel demands, ensuring that the push towards biofuels does not compromise food security or lead to unsustainable agricultural practices [65].

Thus, while promising economic benefits, the integration of bioethanol production into date palm cultivation requires strategic planning to harness its full potential sustainably [66].

The environmental considerations and sustainability of ethanol fermentation from date palms are critical components in assessing its viability as a green energy source. Utilizing date palms, particularly those that are not suitable for consumption, for bioethanol production represents a sustainable approach to biofuel generation. This method not only mitigates the waste of agricultural by-products but also harnesses a renewable resource without competing with food supplies [67].

One way to help combat climate change is to ferment date palm sugar into bioethanol, which could have a lower carbon footprint than fossil fuels [68]. However, it is essential to ensure that the cultivation and processing practices are environmentally sound, conserving water and soil resources while minimizing chemical inputs. Sustainable management practices can enhance biodiversity and support the ecological balance, making ethanol production from date palms an environmentally responsible choice in the quest for renewable energy sources [69].

Potential of bioethanol production from date Palm

Considering ethanol production from date palm resources, several future trends and potential innovations appear promising. Advancements in genetic engineering and biotechnology are expected to significantly enhance the efficiency of ethanol fermentation processes. Scientists are working on genetically modifying yeast strains to increase their tolerance to high ethanol concentrations and optimize their fermentation capabilities. This could lead to a substantial increase in ethanol yield from date palm sugars, making the process more economically viable [60].

Since low-grade date palms are particularly viable in the Middle East and North Africa, there has been a lot of research into making bioethanol from these plants and their byproducts during the past 20 years. You may find a summary of the most recent studies on bioethanol production from various periods in Table 1.

Table (1) The most recent research focuses on the synthesis of bioethanol using several varieties of dates.

Type	production	Condition	Yest	reference
date palm waste	15% ethanol by volume under ideal incubation conditions	72 hr.	Saccharomyces cerevisiae	[70]
low-quality dates	at least 71% more than its theoretical worth	fermenting in a 1 liter container at 30 degrees Celsius and 120 revolutions per minute (rpm) without regulating the pH	Saccharomyces cerevisiae	[71]
low grade date	yield of 33.9 grams per liter	temperature (30°C), starting sugar concentration (75 g/l), pH (5.5), and fermentation period (48-96 hours)	Saccharomyces cerevisiae	[72]
Zahde date	The volume of date palm is typically 10% to 14% by volume, which is equivalent to 300-330 liters per ton.	Temperature 25-30 PH 3-4		[73]
Teggaza and Lebghel" date	between 2.5 and 2.78 milliliters per kilogram per hour	T 30°C for 72 hr.	bakery yeast S. cerevisiae	[74]
Low-Grade Saudi Dates	The yields of berhi dates were 121.0 cm3/L, 136.0 cm3/L, and 136.0 cm3/L, respectively- The sampling dates were 111.0 cm3/L, 122.0 cm3/L, and 128.0 cm3/L, respectively. Dates from the Sukkari were 107.6 cm3/L, 123.3 cm3/L, and 96.6 cm3/L.	Juice concentrations of 107.6 cm3/L, 123.3 cm3/L, and 96.6 cm3/L at 30, 35, and 40 degrees Celsius	Saccharomyces cerevisiae yeast	[75]
low grade	33g/l	The sugar content is 90 grams per liter, the inoculum size is 1 percent, the period is 52 hours, and the pH value is 5.	saccharomyces cereivisiae	[76]
oil palm frond juice	maximum rate of ethanol production (0.24 grams per liter per hour, with a lag phase of 0.12 hours)	Time = 37 C Mix at 150 rpm Time = (0-72) hr.	-	[77]

CONCLUSION

Because they cut down on gas emissions, biofuels are seen as eco-friendly. There have been three distinct phases in the history of bioethanol production. What kinds of basic materials are used determine each generation. It is worth noting that the third generation of bioethanol has a lower price tag than its predecessors. The reason behind this is that the third generation makes use of environmentally harmful and unfit-for-consumption waste materials. These waste materials can be put to good use for a variety of reasons by being converted into fuel.

The generation of biofuels, with bioethanol being the most common form, is dependent on biomass as the principal component of the fermentation process. As a prerequisite, pre-treatment and hydrolysis are carried out. The fermentation process is proceeded by the distillation step. In light of this, the manufacturing of bioethanol is a step-by-step process that requires painstaking efforts to be made in order to achieve the highest possible output while incurring the fewest possible costs.

The selection of the unprocessed materials (raw) is contingent upon the availability of the unprocessed materials (raw). Therefore, the investigation concentrated on the manufacturing of bioethanol from dates, given that Iraq is among the countries that produce dates, along with their byproducts. Researchers have effectively employed proven methods to economically produce bioethanol. However, there is a pressing need for further research to discover novel approaches and tools for advancing the invention of biofuels from renewable and limitless energy sources.

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