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A review on production of biofuel using browning oil

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Abstract
This work portrays production of biofuel from browning oil and emulsification of bio fuel with milk whey which is a component acquired as a result of cheddar making. Biofuel is produced due to completion of transesterification reaction under optimum process condition. Whey is a byproduct of cheddar making and approximately 50% of the total whey which is produced worldwide is normally disposed of without being utilized. The world is running short of fossil fuel due to the increased rate of automobiles and it is vital to meet the growing demands. Hence biofuel is the only alternative. As of late, biofuel has a gigantic potential as a fuel and can possibly diminish the measure of carbon dioxide and nitrogen dioxide discharge which is the reason for an earth wide temperature boost. Biofuel has attracted attention in the past few years as an alternative to fossil fuel. Plants such as sugarcane molasses, corn oil, and vegetable oil are all different sources of biofuel making. Currently, production of biofuel from agricultural residue and food waste is a challenge. Consumption of B100 (biofuel) would create around 10% more NOx (Nitrogen oxide) than oil diesel in light of the fact that the oxygen content in biodiesel increases the formation of nitrogen oxide. Further study in microemulsion of biodiesel with water shows good result in reduction of carbon monoxide. In this paper, a microemulsion strategy is picked as the most ideal choice to produce biodiesel for diesel motor and diminish the emanation of ozone depleting substance. The present review aims to cover the overview, methods and use of making biofuel with a highlight on its benefit.

Keywords: biofuel, emulsification, transesterification, cooking oil, milk whey

Introduction

Over 100 years ago, a splendid designer named Rudolph diesel planned the first diesel motor to run on vegetable oil. He utilized nut oil to fuel one of his motors at the Paris exposition of 1900 [1]. Biodiesel alludes to a diesel-same, processed fuel and ester-based oxygenated fuel from renewable natural source. To meet these increasing demands, biofuel may be produced using natural oils and fats, viz., soya bean, rapeseed, sunflower, coconut, corn, cottonseed, mustard, palm oil, nut, animal fats, squander vegetable oil and green growth synthetically [2].

Global Scenario of fuel consumption

Fossil fuel consumption has increased significantly over the past half century, around eight-fold since 1950 and roughly doubled since 1980. But the type of fuel we rely on has also shifted, from solely coal towards a combination with oil, and then gas [3].

It is discovered that human industry activity between 1970 and 2018 have burned through 385Gtoe (one billion ton of oil equivalent) of nonrenewable energy source and emitted 1143 Gt (gigatonne) of carbon dioxide into the earth's climate. It is discovered that the projected world absolute petroleum product utilization during 2018-2050 is 378Gtoe. We estimate that the 378 Gtoe fossil fuel consumption emit 1122 Gt of CO_2 in earth atmosphere resulting in increase of 1◦c of earth's normal environmental temperature [4].

Indian Scenario

The absolute oil reserve in the nation was assessed to be 786 million ton in 2004-2005. In 2009-2010 the unrefined petroleum production was 33.67 million ton. In 2009-2010, 79% of the country's utilization was imported. The unrefined petroleum import charge adding up to Rs. 3753 billion of every 2009-10 put gigantic weight on the economy [5].

In India diesel had the highest consumption volume of fuel around 88.2 billion liters in 2020. This was followed by gasoline with a consumption volume of about 37.2 billion liters during the same year. Biodiesel alludes to the long chain alkyl ester (mono alkyl esters, particularly (mono) ethyl ester of long chain unsaturated fat like lauric, palmitic, stearic, oleic, and so forth) got from sustainable natural sources through a transesterification interaction.

India produces around 9.2 million tons of waste cooking oil per annum, which is the most noteworthy on the planet [6].

Transesterification

It is the most feasible and promising interaction received and financially known for the production of biodiesel because of its effortlessness. The interaction used to change over inexhaustible organic source of oil to biodiesel is called transesterification [7]. The transesterification interaction is the substance response of a fatty oil with a liquor (methanol/ethanol) with the sight of sodium hydroxide or potassium hydroxide which acts as a catalyst to produce biodiesel [8]. Unsaturated fat biodiesel are created from regular oils, for example rapeseed, palm oil etc. Normally compound reagent methanol is more liked for the transesterification cycle to deliver biodiesel designated as B100 [9].

Biodiesel has a colossal potential as a fuel and has the potential to decrease the measure of CO_2 (carbon dioxide), particulate matter and GHG (greenhouse gas) emanations. Henceforth, there is a significant interest in investigating and building up the utilization of biodiesel fuel. However, the significant obstruction in the commercialization of biodiesel production from vegetable oil is its high feedstock cost [10].

The expense of vegetable oil has critical part in the financial matters of the biodiesel. Along these lines, non-industrial nations cannot stand to use palatable vegetable oil as a crude material for biodiesel production. Utilization of browning oil (waste cooking oil) is considerably less costly than unadulterated vegetable oil and may decrease the biodiesel production cost upto 60-70%. Emulsion technique is employed as a best option to increase performance of biodiesel in diesel engine which helps in the reduction of greenhouse gas emission [11].

Milk Whey

Whey is the side-effect of cheese making; by and large creation of 1kg of cheddar typically produce roughly 9L of whey which is made out of 94% of water, protein, lactose, nutrient and fat [12].

Whey, disposed of as fluid waste has a high biochemical oxygen demand request and synthetic oxygen interest because of the high volume created and its high substance of natural matter and it is a genuine ecological issue [13]. There are three sorts of whey that can be utilized as crude material. To start with plain cheddar whey (a supernatant fluid created in cheddar creation), whey pervades (protein in cheddar whey is eliminated utilizing anultrafiltration layer) and whey powder. Numerous investigations have been performed on the transformation of whey into helpful worth by the addition of synthetic compounds, including ethanol and citrus extract [14].

Source of bio fuel

Biodiesel are delivered from common oils, for example, rapeseed oil, canola oil, soybean oil, reagent methanol is more liked for the transesterification cycle to deliver biodiesel since it is lower cost than ethanol [15].

Micro algae can be changed over straight forwardly into energy, for example, biodiesel, bioethanol and bio-methanol and can be a source of renewable energy. There is a growing interest for biodiesel production from algae because of its higher yieldnon edible oil production and its fast growth that does not compete for land with food production. About 50% of algae weight is oil that this lipid oil can be used to make biodiesel [16].

Browning oil

Several research are focusing on alternatives for biodiesel production from feedstock. Therefore the usage of waste cooking oil relies on the reduction of biodiesel production cost by 60-70% most important obstacle in biodiesel industrialization and commercialization is production cost [17].

People around the world utilize eatable oil for cooking, after which the oil is disposed off. The measure of heat and water expands the hydrolysis of fatty acid and percentage of free unsaturated fat in the oil. The waste cooking oil cost is two to multiple times less expensive than vegetable oil, and it diminishes the expense of byproduct evacuation and treatment [18].

Biofuel production

There are a few techniques for biodiesel production: direct use of vegetable oil, microemulsions, warm breaking (pyrolysis), transesterification or esterification, ultrasonic reactor, microwave technique, supercritical strategy and enzymatic technique utilizing lipase [19].

Direct utilization of crude vegetable oil in diesel motor is not practical because of their attribute of having high thickness at room temperature and low volatilities than business diesel fuel which decrease fuel atomization, fragmented ignition and increase penetration. Fragmented burning or bombed start will prompt the carbon being kept on to the injector genuine motor fouling and cylinder ring staying which would harm the diesel motor [20].

To dispose off the issue because of high thickness of crude vegetable oils, a few techniques have evolved, eg. weakening (mixing), miniature emulsification, pyrolysis, transesterification, ultrasonic reactor, microwave technique, supercritical strategy and enzymatic strategy utilizing lipase [19]. Hence transesterification process is suitable and reliable method for biodiesel production since it is more economical than any other technique.

Biodiesel viscosity lowering techniques

Direct use of rough vegetable oil in diesel engine is not reasonable on account of their property of having high thickness at room temperature and low volatilities then business diesel fuel which reduction fuel atomization divided start and assembles entrance. Divided consuming or bombarded start will provoke the carbon being kept on to the injector authentic engine fouling and Piston ring sticking which would hurt the diesel engine [21].

To get rid of this problem there are several technique using lipase which are briefly explained as followed:

(i)Weakening (mixing). Weakening is probably the most straightforward approaches to diminish the thickness of rough vegetables oil. It is very well achieved by direct mixing or weakened with the conventional diesel fuel. While totally unadulterated (100%) biodiesel is characterized as B100, a biodiesel mix is unadulterated biodiesel blended with the ordinary Petro-based diesel. Weakening can improve the consistency, conquer the motor presentation issue, for example, injector coking and carbon deposition (Diesel fuel injector fouling involves deposit formation on the external and/or internal surfaces of the injector and nozzle) [20].

(ii)Miniature emulsification: Micro emulsion are clear colloidal harmony scattering of isotropic fluid combination of oil, water and surfactant, oftentimes in blend with a co-surfactant. Micro emulsion is not utilized for synthesis of biodiesel as the presence of water will prompt the age of cleanser, longer response time and detachment issue. Accordingly, emulsion is simply a method to decrease the thickness of oil; it is not useful to deliver biodiesel financially because of its lower cetane number and energy content [22].

(iii) Pyrolysis (warm breaking): Pyrolysis is a substitute technique for diminishing the thickness of rough vegetable oils. A pyrolysis measure is a transformation cycle in which vegetable oil is changed over into fuel pyrolysis oil through warming or warming with the guide of impetus without air or oxygen and cleavage of synthetic securities to yield little particles. The focal points of pyrolysis are, it has lower handling costs, great similarity with motors and fuel norms and feed stock adaptability [23].

(iv) Ultrasonic reactors: Here ultrasonic waves are utilized to start the compound response by breakdown of bubbles continually. The waves can heat and furthermore blend the reactant; accordingly the transesterification measure happens. The ultrasonic can diminish the sum of impetus needed upto half because of the expanded compounds action within the sight of cavitation (bubble in a liquid rapidly collapses, producing shock wave). The benefits of utilizing ultrasonic reactor for biodiesel production are decreased response time, response temperature and energy required [24, 25].

(v) Enzymatic technique (utilizing lipase): This technique is called a lipase catalyzed strategy which is the utilization of catalyst as an impetus for the transesterification. The benefit of utilizing lipase is that it is less delicate to high free unsaturated fat content, so a wide assortment of feedstock can be utilized. By and large, methanol cannot be utilized as the reagent in the lipase-catalyzed technique since it inactivates the lipase impetus after one cluster. To tackle the issue, methyl acetic acid derivation is utilized rather than methanol in light of the fact that the lipase is not inactivated and it very well may be reutilized [26].

(vi) Transesterification or esterification: Transesterification, moreover called alcoholysis, is a compound response of an oil (or fat) with a liquor where it is catalyzed by a corrosive or base impetus to shape ester and glycerol [27]. This response incorporates three successive reversible response where fatty oils are changed over to diglycerides and diglycerides then are changed over to monoglycerides followed by the transformation of monoglycerides to glycerol.

In each stage an ester is delivered and subsequently three ester atoms are created from one particle of fatty oil [28].

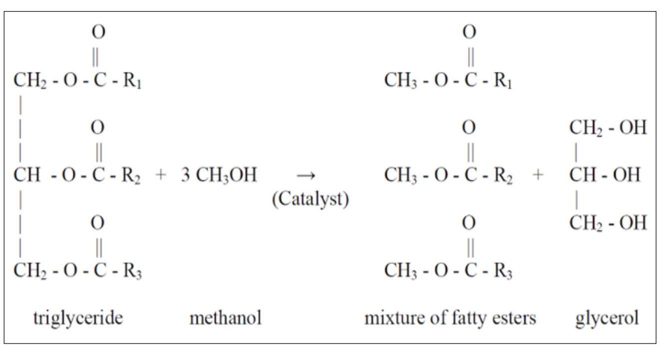

Fig 1: Transesterification reaction

Catalyst selection in transesterification

Biodiesel can be produced by using several kind of catalyst. It can be categorized into two main categories, i.e. homogeneous catalyst and heterogeneous catalyst [29]. The homogeneous catalyst are where the reactants and catalyst are in homogeneous stage (all in liquid form), while heterogeneous catalyst means that the reactants and the catalyst are in different forms meaning that in the heterogeneous catalytic biodiesel production, the reactants are in liquid form and catalyst is in solid form [30]. The most commonly used catalyst for biodiesel production through transesterification process are homogenous based catalyst which includes potassium hydroxide sodium hydroxide sodium methoxide [31].

A. Triglycerides+methanol $\xrightarrow{catalyst}$ methyl ester + glycerol

B. Triglycerides + methanol $\xrightarrow{catalyst}$ methyl ester + diglyceride

C. Diglycerides + methanol $\xrightarrow{catalyst}$ methyl ester + monoglyceride

D. Monoglycerides + methanol $\xrightarrow{catalyst}$ methyl ester + glycerol

Biodiesel -milk whey emulsion

Nitrogen oxide is a main source of a scope of respiratory infection, viz. asthma, emphysema and bronchitis which can prompt untimely demise. It additionally adds to corrosive affidavit which influences the environment. The arrangement of ozone, which can bring about lung harm, is another major antagonist impact of NOx outflow [32]. It is announced that consumption of B100 would create roughly 10% more NOx than regular petrol diesel since the oxygen content in biodiesel expands the arrangement of nitrogen oxide [9]. In any case, there are some other researchers who have come out with different answers to challenge this issue by applying the idea of miniature emulsion of biodiesel with water method.

Their exploration has demonstrated that miniature emulsion of biodiesel-water emulsion decreases the outflow of carbon monoxide, carbon dioxide, unburned hydrocarbon and furthermore the NOx in unmodified diesel motor. Consequently, the microemulsion strategy is reasonable to actualize and research through various kinds of surfactants to improve as far as motor execution and gas discharge are concerned [33].

An immiscible fluid of at least two fluids can be combined to shape a combination is called emulsion. Emulsion includes a combination of oil and water in which one of the stages the scattered stage exists as beads scatter inside the other, it likewise called as the persistent stage [34].

Two phase emulsion

A combination of oil and water can frame oil-in-water emulsion wherein the oil is in the scattered stage and water is in the scattering medium. Another alternative, it can likewise shape water-in-oil emulsion, wherein water is in the scattered stage and oil is in the outside stage. Other than that various emulsion stages are conceivable [35].

Micro emulsions are defined as clear, thermodynamically stable, isotropic liquid mixture of oil, water and surfactant, frequently in combination with a co-surfactant with a droplet which stay in emulsion stage for a long span of time and maintain emulsion stability without phase separation [22].

Macro emulsion is defined either as a dispersion of oil in water or water in oil emulsion are thermodynamically unstable system that tend to break down over time through a variety of physicochemical mechanism including gravitational separation, droplet aggregation (flocculation and coalescence) [36].

It is possible to form emulsion that is kinetically stable for a reasonable period of time by including substance known as stabilizers, e.g., surfactant. An adequate measure of surface active agent, surfactant, which bring down the surface tension between two fluids enables these liquids to blend. Moreover surfactant increase the dynamic stability of an emulsion as it keep up the droplet size and does not vary fundamentally with time [37].

Surfactant selection

To deliver the water and oil emulsion in stage, surfactant is added to lessen the surface strain or interfacial strain of the medium in which it is broken down. Surfactants are short chain unsaturated fats that are amphiphilic or amphipathic; they have hydrophobic group in a single part (their tail) which have affinity for polar media and hydrophilic gathering in another part (their head) which have partially for non-polar med0ia [38].

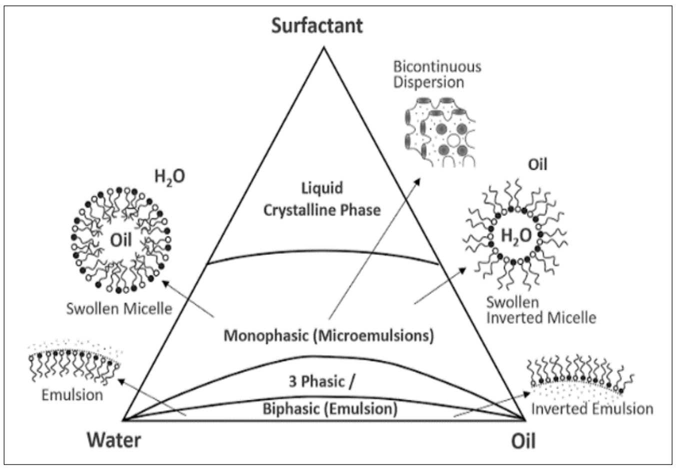

Fig 2: Role of surfactant

In the mass fluid stage, surfactant will form aggregates, eg. Micelles where the hydrophobic tail structure the center of the aggregates and the hydrophilic heads are in contact with the encompassing fluid. The shape of the aggregates relies upon the substance design of the surfactant which is the equilibrium in size between hydrophilic head and hydrophobic tail named HLB, (Hydrophilic-lipophilic balance) [39].

HLB is the dimensionless scale going from 0-20 for non-ionic surfactant; a low Hydrophilic-lipophilic balance alludes to a lipophilic surfactant (oil solvent) and a high Hydrophilic-lipophilic balance to a hydrophilic (water solvent) surfactant. Most ionic surfactant have HLB esteems more noteworthy than 20. Water-in-oil (w/O) emulsifier displays HLB esteems in the reach 3-8 while oil-in-water (O/W) emulsifiers have HLB estimations of around 8-18 [39]. The example of surfactant HLBs are given in Table 1.

The HLB is the indicator of the emulsifying attributes and emulsifier; it does not demonstrate its efficiency. Emulsifiers with higher HLB will promote O/W emulsions on the grounds that there is an extensive variety in the efficiency with which those emulsifiers represent the given framework. Generally, the combinations of emulsifying agent are more powerful than single emulsifying agent, regardless of whether the last HLB is the equivalent. This is because some blended emulsifiers tend to produce a complex at the interface. This interface develops as character yielding low interfacial strain but with a strong interfacial film [40].

If more than one surfactant or if a mix of a lipophilic and hydrophilic surfactant are utilized to set up the emulsion, the HLB value of an emulsifier can be determined by equation. The mix HLB of two surfactants can be determined by the following equation:

$HLB_{AB} = [H_A \times W_A) + (H_B \times W_B)] / [W_A + W_B)$

Where A and B are type of surfactant, H_A and H_B are the HLB value of surfactant, W_A and W_B are weight of the surfactant [40]

Table 1: Approximate surfactant HLB values [39]

	HLB
Oleic acid	1
Sorbitantristerarate (SPAN 65)	2
Sorbitan monooleate (SPAN 80)	4
Diethylene glycol monolaurate	6
Sorbitan monolaurate (SPAN 20)	9
Glycerol monostearate	11
Polyoxyethylene	13
Polyoxyethylene sorbitan monooleate (TWEEN80)	15
Sodium octadecenoate	18
Sodium dodecanoate	21
Sodium octanoate	23
Dioctyl sodium sulfosuccinate	32
Sodium heptadecylsulfate	38
Sodium dodecyl sulfate	40
Sodium octylsulfate	42

Conclusion

Browning oil based biodiesel were more efficient and less expensive than petroleum fuels with spike in petroleum prices and uncertainties concerning the availability. There is renewed interest in browning oil based biofuels for diesel engines.

Application of milk whey for emulsion instead of water emulsion has a promising potential to be adopted in biodiesel production. This is because of salt content in water which affects the biofuel potential and also the engine capacity. Utilization of renewable kitchen waste does not compete with our ecosystem in reducing the effects of global warming. To the extent abatement of the surge of NOx in light of the typical characteristics biodiesel itself has higher oxygen substance and NOx has horrible effects on human and environment. Emulsion is one of the systems to adjust to the current situation. Emission control and diesel engine performance can be done by selecting suitable surfactant and type of emulsion which we need to prefer. Biofuel is a very good alternative for default fossil fuel.

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