Utilization of Food Waste to Produce Biodiesel

Vipin Mundotiya[1], Himanshu Kumar[2], Anshal Kumar[3]

[1]M. Tech scholar, Mewar University, Chittorgarh Rajasthan.
[2,3]Assistant Professor, Department of Civil Engineering, Mewar University, Chittorgarh, Rajasthan.

Abstract - *Biodiesel is gaining more and more importance as an appealing fuel due to the depleting fossil fuel sources. Food waste has triggered managing and disposal issues affecting human fitness and polluting environment. Land disposal is one of the approaches of disposing meals waste however it produces harmful leachate while rain water falls on it. Reuse of meals waste for biodiesel production is one of the key steps to reduce meals waste hassle and additionally meet the electricity call for. Food waste within the gift examine was amassed from the kitchen of a hostel of an academic institute located in India. This waste was dried via numerous drying strategies to dewater. Lesser is the moisture content cloth, greater can be the lipid extraction and therefore improved biodiesel production. It is produced by way of transesterification wherein; oil or fat is reacted with a monohydric alcohol in presence of a catalyst. Lipids were extracted and fatty acids, lauric acid, Mystric acid, palmitic acid, stearic acid and oleic acid had been recognized in gas chromatography-mass spectrometry. These fatty acids diagnosed in lipid suggest the capacity of meals waste for biodiesel manufacturing. Transesterification of lipid became completed to deliver biodiesel and interest of fatty acid methyl ester end up determined the usage of gasoline chromatograph flame ionization detector. Further, biodiesel residences were in assessment with various necessities.*

Key Words: Food waste, Transesterification, Biodiesel, Petroleum derived diesel, clean energy.

1.INTRODUCTION

Overall, petrol utilization has expanded, prompting petroleum product emergency and energy problems in the not-so-distant future because of quick urbanization and industrialization. Till now, the energy emergency has been met by petroleum derivatives which are a restricted asset. Expanded interest in petroleum products has prompted an expansion in fuel cost., what's more, not kidding ecological effects like unnatural weather change, fermentation, deforestation, ozone exhaustion, eutrophication and photochemical brown haze. Worldwide petroleum derivative energy utilization has multiplied over the most recent couple of years. As petroleum derivatives is a restricted wellspring of energy, there is a critical need to look for an elective asset that is financially productive, socially fair and environmentally friendly (M, 2011). Quick urbanization and industrialization likewise create enormous measure of huge waste coming about in dealing with and removal issue. Municipal solid waste (MSW) addresses a little part of total solid waste yet draws in more consideration since individuals and climate are unfavourably impacted. In India during 2015, normal MSW waste generation was 700 tons each day. Municipal solid waste contains a lot of food waste. A few billion gallons of food waste are created from kitchens of private social orders, restaurants, hotels, canteens and food and meat handling enterprises. Everyday gallons of food waste created from various destinations are gathered and thrown in an open region or unloaded in landfill without appropriate disposal strategy (S Barik). Food wastes unfavourably influence nearby water body, land and biodiversity. It leads to genuine environmental and social issues in whole world. In classification of municipal solid waste, India constitutes maximum of food waste (31.9%) when contrasted with different wastes, for example, plastic, material, paper, glass, cardboard, debris, leather and metal waste (Srivastava R, 2014). The most widely recognized method of food garbage removal is landfill. Landfills by food waste are known to produce carbon dioxide, methane and other poisonous gaseous substances (Karmee S K, 2016). Landfill spreads hostile smell and cause perilous impacts on creatures, individuals and climate. It likewise creates unsafe leachate when downpour water falls. This leachate can defile soil and ground water (K, 2014).

Biodiesel can be processed by pyrolysis, thermal cracking, miniature emulsions and transesterification. Transesterification is quite possibly the most widely recognized technique for biodiesel production in which oil or fat is responded with liquor (methanol or ethanol) in presence of a catalyst to form alkyl ester and glycerol. Essential expense of biodiesel production is impacted by cost of feedstock. In this paper an endeavour has been made to reuse food squander for biodiesel production by recognizing and portraying the free unsaturated fats (FFA) present in lipid separated from kitchen food squander. This creative review will assist with limiting removal issue and defeat energy emergency. It will likewise lessen ecological contamination brought about by petroleum product (S Barik).

We want an eco-friendly substitute for energy. Kitchen waste is natural material having the high calorific and nutritive value to organisms, that is why productivity of methane production can be expanded by a few significant degrees as said before. It implies higher proficiency and size of reactor and cost of biogas production is diminished. Additionally, in the majority of urban communities and spots, kitchen waste is arranged in landfill or disposed of which causes the general wellbeing dangers and illnesses like intestinal sickness, cholera, typhoid.

Insufficient administration of wastes like uncontrolled unloading bears a few unfavourable outcomes: It not just prompts contaminating surface and groundwater through leachate and further advances the reproducing of flies, mosquitoes, rodents and other illness bearing vectors. Additionally, it emanates unpleasant odour and methane which is a significant ozone harming substance adding to an Earth-wide temperature boost. Biogas alludes to a gas produced using anaerobic assimilation of kitchen waste. Methane is a clean energy one of the constituents of biogas which has an extraordinary potential to be a substitute fuel. Huge biomass from different organizations could be a source for Methane production where blend of waste treatment and energy production would be a benefit. In state of Rajasthan around of 300 educational institutions are there, from those organizations a lot of waste is delivered yet those waste are not used. Objective of this study is to use the food waste in a bio digester to create biogas which will be the elective fuel for their kitchen energy need. This work was completed to deliver biogas in a Smaller Water Plastic Tank with a decent kind, utilizing different food waste from the mess, faculty quarters, and canteen in Mewar university campus (Rajashekhara K, NCMPC - 2019).

2. MATERIALS AND METHODS

2.1 Sources and generation of food waste

Food waste which is collected from MEWAR UNIVERSITY MESS situated in Gangrar, Chittorgarh of Rajasthan includes vegetables waste, fruits waste and other food items. The treatment process of food waste products gives hazardous waste. The usage of chemicals is one of the main reasons for this. The manufacturing of food items is a process that must be accomplished by adhering to strict controls of both the local and Federal food regulatory agencies. The items of food that are manufactured are as varied as the people they serve. Common staples, exotic delicacies, snack foods and ethnic specialties are all food items that go through a controlled and precise manufacturing process with safety always at the forefront (Rajashekhara K, NCMPC - 2019).

2.2 Sample collection site

Food waste is collected from Mewar University campus, Chittorgarh, India. This sampling location site is chosen because of huge amount of food waste generation. Food waste after collection is brought to the laboratory for further analysis.

2.3 Food waste analysis

About 4kg of food waste is accumulated and taken to the laboratory. Moisture content is removed and standard temperature was determined. Different drying methods were carried out i.e., oven drying (55˚C, 75˚C, 105˚C), freeze drying (-4˚C) and sun drying (25-30˚C) to decide the gold standard temperature. The important venture to be faced for biodiesel manufacturing became green lipid extraction because it incorporates water along meals debris. After drying the sample has been grinded to powdered form. The powered pattern has been used for lipid extraction (Olkiewicz M, 2014)

2.4 Lipid extraction and analysis

Lipid extraction was done in Soxhlet equipment and methanol used as a solvent. The extraction of lipid relies upon on octanol water partition coefficient (KOW). It is described as the chemical concentration within the octanol section to its concentration within the aqueous segment of two-section octanol/water gadget. The organic compound that resides in water segment are hydrophilic and chemical that is living in octanol segment are hydrophobic. After extraction, sample changed into filtered to separate the liquid and solid debris using Whatman 42 filter out paper, 125 mm (dia). Later, the solvent (methanol) was recovered using rotary evaporator by way of evaporating at 70˚C. The recovered methanol became saved and reused for subsequent extraction. The extracted lipid changed into stored in a desiccator in a single day and weighed to calculate the exact extraction of lipid yield. Lipid was similarly analyzed in gasoline chromatograph mass spectrophotometer (GC-MS) to determine the presence of free fatty acids to be able to indicate the potential of food waste for biodiesel manufacturing. The residue left after lipid extraction can further be analyzed and reuse in pharmaceutical to produce medication, capsules and plant nutrients.

3. RESULTS AND DISCUSSION

3.1 lipid analysis and Moisture content

Removal of moisture content is an essential step in lipid yield and biodiesel production due to the fact water present in pattern can also inhibit the solvent to penetrate in the pattern by using surrounding the meals particles. The moisture of the sample is dependent on drying approach and temperature. Different drying strategies were decided on to decide the optimized temperature for much less moisture content material and more lipid yield. In preferred, better the drying temperature, lesser is the moisture content, more amount of lipid yield and as a result biodiesel production (Olkiewicz M, 2014). Sun drying approach gave moisture content of 4.4% in 240 h at drying temperature of 25-30˚C with lipid yield of 15.8%. This method is dependent on weather condition and time ingesting. Freeze drying approach gave moisture content of 7.2% in 48 h. In oven drying 105˚C gave less moisture content material of 0.1% compared to 55˚C (2.3%) and 75˚C (1.5%). When exclusive drying techniques are as compared, it is observed that oven drying approach at a hundred and five˚C gave much less moisture content (0.1%) with lipid yield of 36.9%. Hence, the optimized temperature for drying is 105˚C. Very excessive temperature in oven drying will burn the sample and ruin the fatty acid chain because for biodiesel manufacturing lengthy chain fatty acids are required. To take

a look at the effect of lipid, yield due to variant in meals waste composition, the food waste pattern become amassed weekly (7 days). The lipid yield due to meals waste composition has been discussed in Table 1. Food waste especially include rice, pulses, vegetables together with paneer in vegetarian meals whereas non vegetarian food include meat, fish, fowl alongside oil and fats. Fat content material in 100 g of chicken is 14 g, 100 g of mutton contains 21g fats, 100 g of fish carries 12 g fats, and a hundred g of paneer consists of 20.8 g fat. It is found that lipid yield is extra in case of vegetarian and nonvegetarian compared to vegetarian simplest due to greater quantity of oil and fat. According to literature, more the quantity of oil/fat, extra is the lipid yield extraction and consequently, greater quantity of biodiesel yield.

Table -1: Effect of lipid yield due to food waste composition

S. No.	Days	Food waste composition	Lipid yield (%)
1	Monday	Vegetarian	32.5
2	Tuesday	Vegetarian and non-vegetarian (Non Vegetarian Mess)	37.5
3	Wednesday	Vegetarian	36.8
4	Thursday	Vegetarian	30.2
5	Friday	Vegetarian and non-vegetarian (Non Vegetarian Mess)	36.4
6	Saturday	Vegetarian	37.3
7	Sunday	Vegetarian and non-vegetarian (Non Vegetarian Mess)	37.2

3.2 Lipid Analysis

Lipid extraction was done in Soxhlet equipment using methanol as solvent. Lipids are of types i.e., impartial lipid and polar lipid. Neutral lipids are insoluble in water but soluble in natural solvents including methanol, chloroform, hexane, and so on. Solvent extraction of lipid is achieved to separate the additives dissolved in mixture. The separation of unique compound is feasible because solvent dissolve the targeted compounds (MW, 2009). Targeted compounds including triglyceride can be separated by means of mixing the solution to a temperature close to boiling of solvent so that you can evaporate solvent however cantered compounds will now not. The role of methanol is to extract triglyceride, phospholipids, cholesterol, and so forth. The extracted lipid changed into analyses in fuel chromatograph mass spectrophotometer (GC-MS) to decide the presence of free fatty acids. Table 2 speak approximately the loose fatty acids diagnosed in lipid evaluation. These identified unfastened fatty acids suggest the ability of food waste for biodiesel production (Ferraza T P L, 2004)

Table-2: Free fatty acids identified in lipid analysis

S.N.	RETENTION TIME	ORGANIC COMPOUNDS
1	4.070	Caproic acid (C6:0)
2	9.191	Lauric acid (C12:0)
3	11.181	Mystric acid (C14:0)
4	12.595	Palmitic acid (C16:0)
5	13.741	Stearic acid (C17:0)
6	13.853	Oleic acid (C18:0)

3.3 Transesterification

Transesterification of lipid carried out by using of methanol as solvent and sulphuric acid as catalyst. The reaction was carried out in the ratio 11:1 (methanol: lipid molar ratio) at 60˚C for 2-3 hours and catalyst of 2.4 wt. % became added. It is always beneficial to perform the reaction near the boiling factor of methanol due to proper miscibility of methanol with lipid. Reaction rate will increase with growing temperature resulting in boom in solubility of methanol in oil-rich segment. Higher reaction temperature effects in shorter response time in mass transfer-controlled reaction because transesterification reaction is more favoured at higher temperature (D, 1997). Usually, the transesterification ought to be accomplished underneath the boiling point so that we can prevent evaporation of methanol. It is usually recommended to carry out reaction below the boiling point by way of numerous literatures. (S, 2004) also said that during supercritical state, methanol acts as an acid catalyst in transesterification reaction (S, 2004). Temperature will increase the ability of the reacting molecule and additionally improves the miscibility of alcoholic polar media right into a non-polar oily section ensuing in plenty faster reaction. Due to proper mixing of solvent and lipid in presence of catalyst for time i.e., 2-3 hours result in faster reaction rate and whole conversion of biodiesel. The biodiesel yield of 31.9% modified into received inside the ratio 11:1 at 60˚C for2-3hours and catalyst of 2.4 wt.%. The produced biodiesel ends up washed well using distilled water to remove impurities and received natural biodiesel.

3.4 Biodiesel Properties

To acquired biodiesel became further analyzed to decide its physical and chemical properties after which in comparison with diverse requirements as summarized in **Table-3**.

S.N.	PROPERTIES	ASTM D6751	EN14214	IS 15607 (2005)	OBTAINED VALUE
1	Density at 15°C (kg/m3)	875-900	860-900	860-900	876
2	Kinematic viscosity (mm2 /s)	1.9-6.0	3.5-5.0	2.5-6.0	2.5
3	Acid value (mg of KOH/g),	Max 0.5	0.5	0.5	0.60
4	Pour point (°C)	-3 to 12	-	-	7.5
5	Calorific value (MJ/kg)	-	35	-	30
6	Metals (Na+K) (mg/kg)	5	5	-	2
7	Metals (Ca+Mg) (mg/kg)	5	5	-	1.78
8	Ash content, percent by mass, Max	0.02	0.02	0.02	0.0081

Density of biodiesel bring out from food waste is observed to be 876 kg/m3 which is within the limit in step with ASTM, EN and IS standard. The values rely upon their fatty acid composition in addition to on their purity. One of the most important properties of biodiesel is kinematic viscosity. The kinematic viscosity of biodiesel is located to be 2.5 mm2 /s which within the range of 1.9-6.0 in line with ASTM D 6751 in accordance to test approach D445. This means that biodiesel superior fluidity of gas for diesel engine and precise spray pattern that might generate across the combustion chamber, permitting right blending with air. The acid utility for biodiesel is 0.60mg KOH/g and it exceeds the EN 14214 and ASTM D6751 fashionable in line with which acid value should not exceed the value 0.5mg KOH/g. As triglycerides present in oil and fats converted to fatty acids inflicting a boom in acid number. Pour point is the minimum temperature at which oil starts off evolved to soften or pour. It is the measure of capability of a fuel to function under cool weather situations. The pour factor of biodiesel is determined to be 8°C that's within the variety of ASTM D6751 (-3 to 12 °C). During cold climate biodiesel causes fuel deprivation and operational difficulties which give up the fuel discharge in engine. Calorific value is the dimension of heat or power produced and is measured either as gross calorific value or net calorific value. The gross calorific value of biodiesel measured by bomb calorimeter is 30 MJ/kg that's less than the usual i.e., 35 MJ/kg in line with EN 14214 general. Calorific value of diesel fuel is 45.5MJ/kg Less calorific fee means more fuel consumption. If metal impurities can increase, metallic deactivators may be used to chelate transition and inhibit catalytic oxidation and polymerization effect. Alkali metals could also form soap and purpose insoluble of diesel blends. Alkali metals of (Na+ K) have been observed to at least 2mg/kg and (Ca+ Mg) have been observed to be 1.78mg/kg which is in the variety of 5mg/kg in accordance to standard EN 14538. Ash point describes the number of inorganic contaminants consisting of abrasive solids, catalyst residue, soluble metals contained in gasoline. Ash content material of biodiesel is observed to be 0.0081 that's in the fashionable cost (0.02)

4. CONCLUSION

To control fossil gas crisis, environmental pollutants and meet the energy demand one of the best ways is to replace non-renewable resource with renewable resource. Various researches were carried out to identify the high-quality opportunity manner of reusing renewable sources, most significantly waste product for biodiesel production. Waste merchandise like sewage sludge, business waste, waste cooking oil and many others, are zero value raw substances that may be used for biodiesel production that allows you to help to minimize waste generation, dealing with and disposal problem. In this study a progressive technique to make use of kitchen meals waste for biodiesel production has been initiated. Food waste changed into dried waste and lipid become extracted the use of methanol as solvent with yield of 36.9%. Lipid evaluation became completed in GC-MS to identify the fatty acids. The extracted biodiesel become analysed in GC-FID to decide the concentration of free fatty acid methyl ester. Physical and chemical homes of biodiesel have been carried out and located glad by way of evaluating with one-of-a-kind requirements. The residue as a consequence can be in addition reused by pharmaceutical industries after extracting these metals and also as soil and plant nutrients. This reuse technique is a revolutionary sustainable technique to reduce gas crisis, inexperienced residence emission and waste disposal troubles.

ACKNOWLEDGEMENT

I am very grateful to almighty who have given me the chance to do the project and have given me patience & power to start my project. I wish he will keep me sound physically and mentally throughout the period, as I can complete the project successfully. I wish to express my gratitude to my parents. I am also grateful and indebted to the faculty members of Mewar University of Engineering and Technology and also thanks to my friends, who helped me directly or indirectly whenever it required.

References

1. D, N. H. (1997). Kinetics of transesterification of soybean oil. J. Am. Oil Chem. . , 74 1457-1463.
2. Ferraza T P L, F. M. (2004). Comparison of six methods for the extraction of lipids from serum in terms of effectiveness and protein preservation. J. Biochem. Biophys. Methods 58 187–193.
3. K, K. S. (2014). Valorisation of food waste to biofuel: Current trends and technological challenges. Sustainable Chemical Processes . 2 (22).

4. Karmee S K. (2016). Liquid biofuels from food waste: Current trends, prospect and limitation. Renewable and Sustainable Energy Reviews. 53 945–953.

5. M, E. N. (2011). The manufacture of biodiesel from used vegetable oil A thesis submitted to the faculty of engineering at Kassel and Cairo Universities for the degree of Master of Science 12.

6. MW, H. (2009). Extraction and characterization of lipids from microalgae grown on municipal waste water. A Master's Thesis Presented to the Faculty of California Polytechnic State University San Luis Obispo.

7. Olkiewicz M, C. M. (2014). Direct liquid – liquid extraction of lipid from municipal sewage sludge for biodiesel production Fuel Proc. Technol. . 128 331-338.

8. Rajashekhara K, D. N. (NCMPC - 2019). Production of Biofuel from Food Waste. International Journal of Engineering Research & Technology (IJERT).

9. S Barik, K. P. Utilization of kitchen food waste for biodiesel production .

10. S, K. D. (2004). Effects of water on biodiesel fuel production by supercritical methanol treatment. . Bioresour. Technol. 91 289–295.

11. Srivastava R, K. V. (2014). Characterization and management of municipal solid waste: a case study of Vanaras city, India. International Journal of Current Research and Academic Review 2 , 10-16.