A STUDY ON CONVERSION OF WASTE FOOD GENERATION INTO USEFUL RESOURCE

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Abstract: ***Biofuel possesses high biodegradability and lubricating property which improves engine efficiency also to reduce our dependence on fossil fuels and to lower emissions of greenhouse gases(particulate matter and carbon dioxide emissions). As renewable biofuels generally contain carbon fixation. Biofuel can be carbon-neutral because all biomass crops sequester carbon to certain extent basically distinctive promise is, in combination with an emerging technology called carbon capture and storage. Biofuels which can be produced from renewable domestic resources offer an alternative to petroleum based fuels. The main contribution of this work lies in comparative study of different methods which are processed by different researchers. This study shall help the policy makers to choose the best criteria out of these methods while formulating newer edition method.***

Key Words: biodegradability , lubricating , carbon capture , sequester , domestic resources

I.INTRODUCTION

Overall we see that global consumption of fossil energy has increased more than 1300 fold. The theory which formalize fossil fuels is from remains of dead plants by exposure of heat or pressure. As generation goes on this fuels goes to crises to human beings because it creates hazardous impact on day to day lifestyles in different forms. Some like polluting environment, increasing global warming, coal mining operations wash acid runoff into streams (rivers, lakes, etc), fossil fuels emits harmful pollutants etc. Hence its being a great responsibility to increases demand for renewable sources. As the renewable sources not only helps to alternate the energy issues due to consumption of fossil fuels to worldwide economic evolution but also reduces outpouring of greenhouse gases and assist to support eco-friendly balance and ameliorate personage livelihood environment.

Now deliberation has been attentive on the thermal methods for transformation of biomass to biofuels (biogas, bio-oil , biochar). Throughout previous ten years some methods has been studied.

II. PROCEDURES

In association with them one method has been focused that is hydrothermal carbonization technique (HTC) is considered as specific because of its high versatility (Gai et al.. 2015; Yu et al.. 2011). By figuring it the product named hydrochar had increased its heat of combustion (calorific value), desiccation and homogenous properties. Along with this also the fuel properties like the carbon content ratio is perfectible and fixed also much dependency on hydrothermal frameworks like temperature, residence and time (Reza et al.. 2012; Simsir et al.. 2017; Wang et al.. 2018a). In accompaniment to increase fuel properties pelletization process with HTC is introduced. The attention is given to energy density and mechanical strength of hydrochar

fuel(Lie et al 2014). As the process begins with heating woody mass under 250 to produce pellets and the in which the carbon fixation has increased up to 20 to 30 % and calorific values (4-6 Mj/kg) as compared to raw material (biomass) and liquid connection increased tensile strength.(Liu et al.. 2014)

According to previous examine outcomes the heating of hydrochar from 250 formed pellets is with lower tensile strength also at 200 the lignin which cant form rigid(solid) bridge and also energy utilization was high. (Wang et al. 2017)

Another nearly recent study shows that hydrochar pellet has very poor mechanical strength because the lignin content was limited as food waste must content of protein, carbohydrate(starch, glucose) and unalterable ways in hydrochar pellets depends on attraction forces.(Zhai et al.)

Nevertheless current studies shows mainly on the hydrochar pellets. Thus it has been concluded that the main dependency of fuel properties and mechanical properties of hydrochar pellets hangs on constituents of raw materials and formulating conditions of HTC.

Lastly the in this study the formation of hydrochar from various food wastes at 180-260℃ for production of fuel pellets was done by also evaluating the basic properties of fuel , mechanical strength , storage attribute , heating characteristics , energy consumptions, etc were determined for solid biofuel manufacturing. (Tangfei Wang, Yumbo Zhai, … 2018).

The challenges to overcome are:-

1. Carbon Fixation
2. Calorific (heating) values
3. Issues on tensile strength
4. Energy Consumptions

As the other method which had been focused after this is for the production of bio-ethanol. Some recent studies and researches had focused on the second-generation biofuels in which the waste food used as raw material. As first-

generation biofuels were made to consume sugar and starch content. (Matsakas L , Cristakopoulos P…. 2013) (Moon HC, Song IS… 2009)

This method contains lignocellulosic biomass derived from woody material and agricultural left over residues (corn cobs, wheat, straw, bagasse etc) as reason behind this raw material would be due to large quantity of produced in year as waste(Zhang M, Wang F, …2010). The main challenges faced in deploying the lignocellulosic biomass effective mostly from cellulose (Silva VN, Arruda P, Felipe MA, Gonclaves A, Rocha..2011). Straight to attain this briefing a method followed by enzymatic hydrolysis process appealed. An possible substitute of raw material for production of this kind of biofuel used is household food waste (HFW) because the annual HFW produced according to EU-26(European commission) in 2006 evaluated is 37.7 Mt means 76kg per capita and further increases up to 126.2 in 2020.

The main target of this study is to consume the source detached HFW for the production of bio-ethanol at dry material grade (DM) to accomplish high amount of bio-ethanol. But here only solid state development applied so it creates a viscous pulp. Hence its an major issue for processing and recovery of bioethanol. To conquer this barrier an process named enzymatic liquefaction/saccharification is applied advance to compare with fermentation.(L and Novozym 188)

One of recent research shows another method named gravimetric mixing system along with liquefaction which has also claim auspicious and it was applied for pre-treatment of lignocellulosic feedstock similarly at DM content. (Jorgensen , Larsen J Petersen)

Throughout this process the viscosity of solid state pulp has quickly decreases, however conceal with fermentation also introduced. Eventually at the end the enzymatic liquefaction/saccharification along with fermentation is applied.(Leonidas Matsakas,…2014)

The challenges to overcome:-

1. To efficiently consume sugar
2. To form low viscous pulp

Similarly one another study has made by another researcher by utilising of kitchen waste to produce biodiesel. According to studies regularly the development of the urbanization and industrialization has increased which means the generation of solid waste increased and provoke the handling of its disposal and a major deliberation has done by humans because it creates catastrophic effect in environment(Goel S..2008) . An report has made on municipal solid waste generation (MSW) like :-

In India during 2015 an average MSW generation was 700 tons per day. In common particularly billions gallons of food waste generated(Pandey SK, and Gupta AK.. 2007) . Not only it causes environment but also affects water bodies , ecological diversity , also hazardous impact on animals.(Karmee SK .. 2016)

To overcome this problems the methods for production of biodiesel are implemented some methods are:-

1. Thermal cracking
2. Pyrolysis
3. Micro- emulsion
4. Transesterification

III. EXPERIMENTAL WORK

As per the introduction of first method the different types of food and other kinds of waste are collected over worldwide with varying composition values some are as follows:-

raw and cooked vegetables, noodles, meat, some paper cups. From this food wastes the bones and plastics are separated because of operation restrictions. As per above discussion the process named hydrothermal carbonization was implemented in suitable conditions like:-

Equipment:- Reactor

Material:- 316 stainless steel

Capacity:- 500ml

In a fixed feedstock taken and done in trial forms like (food waste were taken in different concentrations 0% , 25% , 50% , 75% , 100%) than it goes further in autoclave with addition of 200ml of deionised water. After that the reactor was heated at different temperature values 180 , 220 and 260 for about one hour. The rate of stirring was commanded by an electromagnetic agitator at rate if 100rpm. After an hour when the reactor itself gets cooled down at the suitable room temperature in which solid remnant(residue) was separated by process of vacuum filtration. From that hydrochar put to dry at 105for one day in drying oven , after than grinded in powder through mesh size of 40.(Jiang et al 2014)

Including this pelletization process is done as individual pellet was pressed during hydrochar process in equipment named cylinder piston along with heating tape which is applied around cylinder and temperature is maintained by thermocouple. (Jiang et al 2014).

As the pelletization process occurs alternately before pressing pellet about 10% (w/w) extra amount of water is added in-order that waste may be act as lubricant during pelletization process. For single trial about 0.6 gm of hydrochar was added after that when compressing force reached to its limits i.e. 4kN and was operated for 30 seconds of time and temperature maintained at 90 under this condition lignin forms a natural binder along with pellets.(Reza et al .. 2012)

The energy consumption of pelletization process is evaluated online including compressive force and displacement by suitable considerations of pellet measurement like mass, length, diameter, and this type of solids are stockpile at 4for seven days. Hence the expansion in length is calculated by given equation

$$\text{Expansion length} = (Li - Lo)/Lo$$

Where Lo = Initial length of pellet

Li= Length of pellet after seven days

Also to measure tensile strength(Ts) the pellet was placed horizontal in middle of compressive force and anvils was given extent up to it may broken and in that the maximum amount of force is observed. Hence the tensile strength was calculated by given equation(Liu et al. .. 2014, Wang et al… 2017)

$$Ts = 2f/\pi ld$$

Here, f = Maximum force applied

L= Length of pellet

D= Diameter of pellet

Its proved that high temperature allows decarboxylation and dehydration processes. Also with increase in temperature

180 to 260 there is increase in carbon content continuously but due to hydrochar seems more trust on food waste blend than accordingly the nitrogen ratio varies. Therefore we can say that the content of nitrogen in hydrochar was increased by increase in temperature and this enables for more hydrochar production form food waste. (Wang et al 2018). As it is known that the nitrogen can easily absorb due to different carbonization reactions which mainly happens between protein and sugar(Kang et al.. 2012)

From this research it has been concluded that the content of food waste blended for carbonization process with HTC mainly seems the decreasing value of hydrogen to carbon ratio(H/C) from 0% to 50% also decreasing value in oxygen to carbon ratio (O/C) from 75% to 100%. From results it can said that during pelletization process the decrease in consumption of energy would lead to increase in ratio of food waste , hence the pellets of hydrochar which was made by high content of food waste at low ignition and high temperature range was obtained. In alternative to this instead of pelletization another process named co-hydrothermal carbonization was applied with the content of food waste from 50% to 75% at 220 temperature to produce solid biofuel for future practical purposes (Tengfei Wang….2018). As another method is studied for production of bioethanol. The present sugars like glucose, sucrose and fructose has highest content of cellulose which can further readily converted in to bioethanol. Therefore according to previous study of researchers in literature are that they measures food waste by chemical oxygen demand (COD), volatile solids(VS) and (BOD) biological oxygen demand(et cetera 2013).

To apply most applicable and efficient method for production of bioethanol it is important to know the basic proportions of insoluble and soluble sugars also which type of insoluble polysaccharides are use for most efficient type of enzymatic hydrolysis process(Zhang and Richard.. 2011). The compositions of waste food is provided in expanded variety which is shown in tabular form which should be present in food waste

Compositions	w/w
1. Starch	34.8%
2. Reducing Sugars	23.3%
3. Amylases(Moon et al..2009)	1.6%

The above tabulated composition was given by (Moon et al 2009)

Another composition was given by other researcher (Yan et al. 2011)

Composition	w/w
1. Starch	30.1%
2. Fiber	14.9%
3. Reducing Sugars	17.6%
4. Amylases	63.5%

As after the equivalent amount of composition taken from above than process named liquefaction/saccharification is performed for eight hours from DM material which is allowed previous for fermentation process content at 45% w/v with other DM contents are fermented at 35 and 45% w/v. Now it has been found out that the maximum yield of bioethanol after 15 hours is from

1. DM at 35%w/v → 34.85 g/l
2. DM at 45%w/v → 42.78 g/l

But when considered initial content of cellulose in obtained products then it is 0.443g/g at 35%w/v and 0.423g/g at 45%
Hence it is proved that the maximum bioethanol yield after fermentation process was from 35%w/v DM Which could be applicable for further treatment. After doing the main treatment i.e. liquefaction/saccharification it increases the efficiency of product and also cause reduction in viscosity (Kem et al. 2011)
To increase the content of DM it is also found out that by doing separate hydrolysis and fermentation instead using liquefaction/saccharification (Manzaneres et al. 2011) and resulted that this separate step increases the fermentation of hot water liquid (Hoyer et al. 200 9). The comparison was done between theories of these given researchers and concluded to work on previous method instead of Moon et al. As per previous theory the liquefaction process takes place for three hours of waste food with content of carbohydrases and amyloglucosidases in which the bioethanol production goes up to 29.1 g/l (Walker et al. 2012).
The fermentation of process done at 35% and 45% (w/v) DM liquified process for pre-treatment which is done at flasks name Erlenmeyer 100ml. The microorganisms used during fermentation is bakers yeast added in DM 15mg/g. Now to understand importance of liquefaction/saccharification process the different types of trials are made with different intervals of time. After completion of fermentation process the broth has been filtered out through vacuum , which is further washed with the distilled water to remove solid content from it. Afterwards the solids are dried in drier at 60 till weight becomes constant and lastly used for bioethanol production which is hydro thermally pre-treated.

In an laboratory for this experiment about 2kg of food is collected in different compositions and from that some amount of moisture content from it are removed. Moisture content removed from waste food at considerable temperature by different methods some are as follows:-

1. Oven drying :- Operated at Different temperatures (55 , 75 , 105)
2. Freeze Drying:- (-4)
3. Sun Drying:- 25-30

Important challenges facing during this process is to more lipid extraction along with water. After drying food waste, had been grinded into powdered form and this powder is useful in more extraction of lipid.
Extraction of lipid and Analysis based on that:-
An equipment named Soxhlet apparatus is use for lipid extraction by using solvent as methanol. After process of extraction the liquid and solid particles are filtered out by using whatman 42 filter paper of size 125mm diameter , after that the solvent which is used during lipid extraction by

equipping rotary evaporator at 70 the recovered solvent methanol is stored in which can use for next process, so there is none any wastage of solvent. The lipid which was extracted was stored in dessicator through whole night and then it is weighted by weighting machine to evaluate the maximum yield of lipid. The test name gas chromatograph mass spectrometer (GC-MS) is introduce to analysis to determine how much fatty acids content are present which further indicates the potential of waste food for production of bio-diesel. Now after analysis the lipid content which was remain left as residue is can be reused in pharmaceuticals industries in preparation plant nutrients, medicines and drugs.

Hence now the process named transesterification was introduced for converting food waste into biodiesel by utilising acid catalyst. The process starts from here as the known quantity of lipid was taken in RB flask with solvent as methanol and catalyst as sulphuric acid put closed. Probably the excess amount of methanol is added in this solution so that a maximum conversion takes place of fatty acids in to fatty acid methyl ester [FAME]. (S Barik.. 2018)

After FAME for separation of glycerol and biodiesel is done in which suddenly the solution is kept for cooling and which was taken to separatory funnel for 24 hours and as talked the methanol was recovered using rotary evaporator at 70℃. The main key fraction of this process is removal of glycerol and glycerides because biodiesel mainly shows dependency on glycerol content and if high concentration of glycerol present in biodiesel it can cause many problems like emission of aldehyde and storage problems. (Faccini C S. 2011).

Also an important step to wash biodiesel for removal of catalyst and impurities. Lastly the biodiesel which was purified was analysed from test named gas chromatograph flame ionisation detector (GC-FID). After that the different properties of biodiesel was compared with different standards. Composition of food waste taken are as follows:-

As it is known that food waste mainly consist of rice, pulses, peels of vegetables, paneer. Here it has been seen that the amount of fat content is more in non-vegetarian food as compared to vegetarian and it has been told that more fat content means more lipid content, hence more lipid extracted.

Also it has been evaluated the amount of lipid extracted

1. Maximum from vegetarian :- 32.5%
2. Combine Vegetarian and Non-vegetarian:- 37.3%

Sample Taken	Amount of Sample	Fat content in sample
1. Chicken	100gm	14gm
2. Mutton	100gm	21gm
3. Fish	100gm	12gm
4. Paneer	100gm	20.8 gm

From above test it has been evaluated that the production of biodiesel by transesterification process is somewhat alternative useful method from above given processes. But this process is very much time consuming which is the main factor responsible of not using it. In process the waste food was dehydrated for maximum lipid yield Therefore current trending technologies are finding solutions regarding production of biooil.

This is another method of conversion of waste food which usually contains volatile fatty acids in to lipids.

IV. Conclusion

As expressed from the above information several methods are been concluded in which different methods are been analysed by different researchers. This all methods are better but cant utilised due to limitations. According to me the vegetable oil should be utilised to produce biofuel it is economical process

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