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Bio-Energy Recovery from Canola Oil and Wastewater as Co-Substrates

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ABSTRACT

The attention to renewable energy increasing as a result of global energy security problems, climate change, and environmental pollution, therefore we found that the rates of renewable energy applications are increasing progressively over the years. In general canola oil can be utilized as an energy source through transesterification which increases its value. This research is aimed to appreciate the feasibility of using canola oil with the wastewater through biological technology. Canola oil should induce high methane production potential but this does not happen without certain drawbacks. For this purpose, canola oil was co-anaerobic digested with wastewater under different loading rates, a continuous stirred tank reactor (CSTR) was used for anaerobic digestion, and the experiment was conducted for 60 days at 37˚C. Hence, evaluate digestion conditions, stability, and affect the overall operational efficiency depending on canola oil characteristics.The results showed that it was noticed that the biogas production varied from 620.12 –1569.20 l/kg$_{ots}$.day depending on OLR 1-3 g$_{oTS}$ l^{-1} d^{-1}.The highest biogas production was 47 l/day with methane content 69.19% when the loading rate was 3 g$_{oTS}$ l^{-1} d^{-1}.Co-digested canola oil with wastewater produce a methane yield that may reach up to 47 l/day with methane content 69.19%, the highest one produced by 3 g $_{oTS}$ l^{-1} d^{-1} While increasing loading rate lead to increase VFA, decrease pH level and the production.The ratio of output /input energy reached to1.9 if canola oil used as biogas substrate but be 1.3 when canola oil used as biodiesel source.

Keywords:Biogas;Canola oil;Organic loading rate;Calorific value;Energy generation;Biodiesel

INTRODUCTION

In the last few years, there has been a growing interest in biofuel energy sources, sustainable development, and eco-friendly ideas as a result of the fossil energy resources decrease, and environmental problems increase. Various biofuel energy resources explored include biogas, bio-alcohols and biodiesel. Gasification of biomass through the anaerobic digestion process allows transforming it into biogas, which is much more appreciate to obtain heat, mechanical , and electrical energy. Biogas production technologies are ideally suited to the developing countries, for providing fuel, electricity, and high-grade fertilizer. The anaerobic digestion process (AD) or also it's known as bio gasification involves the transformation of organic compounds in an oxygen-free environment to useful energy carrier gas called biogas.

Undoubtedly, the biofuel cost considers as a vital factor to the selection, another and probably more substantial factor that should be considered when valuing market prices for biomass and biofuel energy.

Generally, canola oil produce by extracted from the oil-bearing canola seed by squeezing it out. Canola oil can be used to produce a renewable fuel called methane through anaerobic digestion technology, whereas using oil as a substrate in anaerobic digestion induces high methane production potential. However, this does not happen without appointed drawbacks. In this study, the anaerobic digestion opportunities and challenges linked with canola oil as a substrate are identified by dissection of factors that affect anaerobic digestion.

Canola oilseed contains 40–45% oil, the oil percentage in it is the same as sunflower seed and higher compared to other oilseeds as soybeans, which the oil percentage about 18–20% recorded by Yadava *et al.*, (2012).

In 2014, the world production of canola seed oil was 26 million tons according to (FAO, 2016). Approximately 23 kg of canola seed used to extract 10 l of canola oil, while, the remainder from the extraction process (canola meal) can be used as animal feed. Canola oil now serves as the essential feedstock in Europe for biodiesel production Encinar *et al.*, (2018). The canola oil is widely used as a source for biodiesel production in an effort to reduce the cost of production, whereas it is less expensive than other vegetable oils and therefore has become a favorable alternative. This research opens a new chance, for valorizing canola oil as a source for another kind of biofuel by incorporates the digestion process into the bio refinery concept (anaerobic digestion). Applying the anaerobic digestion technology approve many advantages as produces much more stable digestion, required less energy and generates less wastewater cited by Ferreira *et al.*,(2012).

Generally, Oils are rich in unsaturated long-chain fatty acids that help in bio methane production potentials (BMPs), which make it are comparable to the conventional substrates, like animals dung, wastewater, and sludge waste confirmed by Carvajal *et al.*, (2014).

The foaming formation might be further complicated with oil-based digestion systems because of the presence of fats, which have a high tendency to float. At the same time, it must be borne in mind that foaming can be affected by several factors as organic loading, mixing regime, temperature, and type and size of solids as proposed by Ganidi *et al.*, (2009).

Several previous studies concluded that the microbial communities can be managed through organic loading rate

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(OLR) fluctuations so the biogas production can also be controlled as described by Ferguson *et al*., (2016).

The High OLR leads to increase volatile fatty acids (VFA) concentrations and at last reduces pH in the digester and this condition prevents methanogenic growth and activity in the digester. An equally significant aspect with high OLR is the bacteria washout, which also leads to process failure. Accordingly, OLR can be used as a device, to manage the microbial communities in the digester, whereas every new load causing a different variation in the microbial profile, so support digester resilience to any future shocking. Thus, the optimization of OLR is pivotal to the success of digestion as recommended by Szewczyk and Bukowski (2008).

In terms of methane production, Jiang *et al*., (2018) reported that generally increasing of OTS substrate induces a higher methane production and the low methane production is associated with lower OTS. At the same time increase in methane production with a rise in OTS is not unlimited whereas an increase in OTS leads to prevent the substrate from transfer across the cell walls of the microorganism and this will subsequently decrease methane yield.

The percentage of row feedstock in the mixture is significant factor, whereas the biogas production can be significantly increased by 67.68% depending on OTS added to digester, so feedstock's percentages have to put into consideration as proposed by Metwally, (2019).

The agitation is a very important parameter to optimize dealing with oil material, whereas detrimentally high organic loadings causing foaming and possible digester instability, Therefore, Mild agitation requirements can be done with frequent substrate feeding instead of long breaks before feeding as informed by Kumar *et al*., (2013).

The objectives of this study are to (i) investigate the opportunities of the anaerobic digestion related to canola oil are specified by analysis of factors that influence anaerobic digestion as different organic loading rates; (ii) explore the bio-methane potential compared to biodiesel from canola oil; (iii) reduce the cost of canola oil by increasing the utilization efficiency for energy generation.

MATERIALS AND METHODS

The digestion experiment was carried out as a proposed way to valorize the canola oil and consolidate the anaerobic digestion process into the biorefinery concept. For this proposal, a virgin biomass resource 'canola oil' was utilized, and it has never been utilized as a substrate before for the biogas production.

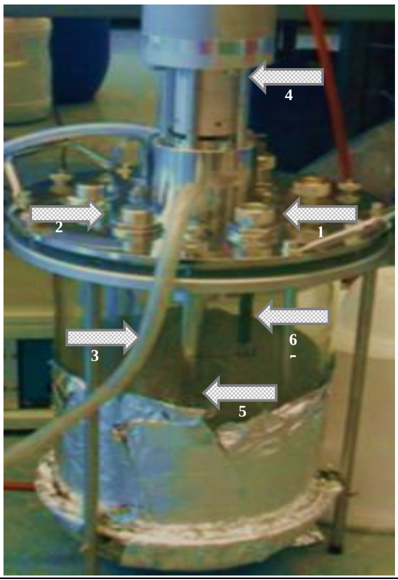
Reactor and experimental setup:

The experiment was conducted using a continuous stirred tank reactor (CSTR), cylindrical in shape, a double-walled glass with a working volume of 10 l, it was operated under a controlled mesophilic temperature of 37ºC.

The generated biogas was collected via a tube attached to the gas sampling (gas bag). Feeding of new material and withdrawal of digested substrate was done through the sampling port on the top of the reactor. The reactor contents are completely mixed with mechanical stirrers using an electrical motor. The stirring interval and its intensity are set as required depending on the foam formation, wherefore the stirring system was turned on every 5 hours. Figure (1) shows the basic structure of a continuous reactor.

The reactor was initially filled with anaerobic sludge taken from an industrial-scale anaerobic treating with effluents from animal farm wastes in order to increase the microbial activity. The sludge was prepared by automatic agitation in order to homogeneity before setting them into the digesters.

The substrate adding was 1 - 3 g_{OTS} l^{-1} d^{-1} seeded initially at a low OLR since it was expected that loading a higher amount may lead to process inhibition. Subsequently, it was increased the OLR step by step, depending on the conditions of the fermenter. During the experiment period, the digester was manually fed once a day, and samples were always previous to the loading process for analysis. The OLR of canola oil was increased when the biogas production starting in decreasing.



NO.	Part Name
1	Substrate additional
2	Substrate removal
3	Biogas outlet
4	Agitator-Mixing device
5	Stirred –tank reactor 15l
6	Thermostat gate

Fig. 1. A continuous reactor.

Nitrogen gas was used at the beginning and after each liquid sampling to create anaerobic conditions. The digestion process was conducted until the increase of the daily gas production reached a minimum and neglected amount.

Analysis methods

Various analyses of the substrate, inoculum, and biogas were carried out over the experiment in order to evaluate the process. Process stability is assessed on the basis of the parameters examined. The factors are scrutinized under several sub-headings as process conditions and parameters. The Characterization of substrate is shown in Table 1.

Table 1. The Physicochemical properties of canola oil.

Parameters	Canola oil
pH	4-5
Density at 20 ºC (kgm^{-3})	920
TS (g/kg)	999.0
VS (g/kg)	998.8
Energy Value	3700 GJ from kg

Operating parameters

The aim of a biogas plant is to produce as much methane as possible from the existing substrate. For this reason, parameters are important that provide information about the performance level of a system, some important of them are briefly explained below.

- **TS - OTS:** The parameters tested included total solids (TS) and organic total solids (oTS) content. TS and OTS were measured according to the standard method APHA (1998). Total solid percentage (TS %) was determined after a 24-hour drying period at 105°C. Organic matter was determined based on ash percentage, samples have been incinerated at 550°C for three hours.

The values of total and volatile solids of inoculum (TS and OTS) was 37.89 and 23.28 g/kg respectively. All analyses were done triplicate and mean values were reported.

- **pH:** The pH was measured regularly using Jenway3020 digital. The pH values were almost ranged between 7 and 8 throughout the experiments and this is appropriated for anaerobic digestion.
- **Biogas-methane:** The biogas production was measured by water displacement device and normalized to standard conditions, the biogas production measured daily.

There is also, a vital point has to put into consideration that measures methane percentage regularly such as biogas measurement. The composition of biogas was measured according to Ezekoye and Okeke (2006) method, whereas the biogas samples were injected into a tube filled with 40% KOH so the CO2 took off, thus CH4 % can be estimated by subtracting the inlet from the outlet volume.

Experimental measurements

- **Potential biogas-methane:** The stoichiometric method according to Jorgensen (2009) was used to estimate the potential biogas and methane production, acting as if fermentation is done completely.
- **The calorific value:** Improve the transformation from the potential energy of the substrate to methane energy is one of the main aims of this study. Thus, evaluation the energy losses through the fermentation process and in fermented residues so energy balance can be done.

The calorific value defined as the heat released during the combustion process and it is one of the physical aspects to energy comparison.

According to (OECD/IEA Electricity Information) the calorific value of methane is 50 MJ/kg - 36 MJ/ m^3

$$\mathbf{C.V = M.P \times F_c}$$

Where: C.V = Calorific value (MJ /kg), M.P = total methane production (m^3/kg), and F_c = conversion value = 36 (MJ.m^{-3})

- **Energy generation:** According to Achinas *et al.*, (2017) The methane energy can be estimate as 35% of energy efficiency combined heat power with heating value 21 MJ·m^{-3}, which meaning that 1 kW.h = 3.6 MJ.

$$\mathbf{E.G} = \frac{\mathbf{B.Y \times H.V \times \eta_e}}{\boldsymbol{F}}$$

Where: E.G = Energy generation (kW·h), B.Y = Biogas yield (m^3), H.V = Heating value (MJ·m^{-3}), η_e = electrical efficiency, and F= conversion factor = 3.6 (MJ.$(kW.h)^{-1}$)

Organic Loading Rate (OLR): the loading rate indicates how many kilograms of organic dry matter (OTS) can be fed to the digester per cubic meter of work volume per time interval and is therefore used as a special value for the digester design. The OLR should be slowly increased to the limit of process stability.

$$\mathbf{OLR} = \frac{m \cdot c}{V_R \cdot 100} \quad [g_{OTS}\ l\ d^{-1}]$$

Where: m: Amount of substrate supplied, (g/d).
c: Concentration of the organic substrate, (% OTS).
VR: Reactor volume (l).

There is a reciprocal relationship between loading rate and residence time: with increasing OLR, more substrate per unit of time is fed to the digester.

- **Biogas (Y_{biogas}) - Methane yield Y_{CH_4}:** It results from the quotient of the amount of methane produced and the amount of organic matter used.

$$Y_{biogas} = \frac{V_{biogas}}{m_{oTS}} \qquad Y_{CH_4} = \frac{V_{CH_4}}{m_{oTS}} \qquad [NL\ g^{-1}_{oTS}]$$

Where: V_{biogas}: Biogasproduction, (NL/d), V_{CH_4}: Methane production ,(NL/d). ,m_{oTS}: Supplied organic dry matter, (g oTS /d).

RESULTS AND DISCUSSION

Biogas and methane production:

In this paper, we explore the possibility of invest the biodegradability of the canola oil, wherefore the total volume of biogas production was measured over time. In this aim, a curve of biogas production was plotted with time, see Figs. 2 and 3.

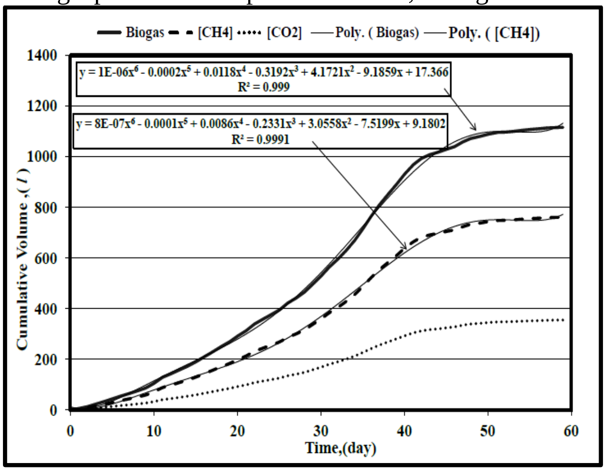


Fig. 2. Evolution of cumulative biogas production.

The production was analyzed by adopting regression models using Polynomial type (order 6). The Regression Equation is $y=a+bx_s+cx_s^2+dx_s^3+ex_s^4+fx_s^5+gx_s^6$, Where y can be represented as the cumulative biogas or methane yield (y value in the curve), x is the time (x value in the curve), while a, b, c,d,e,f,g are regression constants.

The regression equation can be used to evolving predictive models for the generation of biogas/methane through continuous fermentation of canola oil for retention time. The average Values of biogas and methane production were 771.37 and 525.80 l/Kg respectively.

From the curve the regression equation for biogas production was $y = 1E\text{-}06x^6 - 0.0002x^5 + 0.0118x^4 - 0.3192x^3 + 4.1721x^2 - 9.1859x + 17.366$ and $y = 8E\text{-}07x^6 - 0.0001x^5 + 0.0086x^4 - 0.2331x^3 + 3.0558x^2 - 7.5199x + 9.1802$ for methan production.

The analysis of biogas indicates that The percentage of methane was ranging 66-71%, while the carbon dioxide percentage was 29-34%.

Process parameters and conditions

Organic loading rate (OLR)

As shown in Fig. 4, it can be seen that the OLR for canola oil was varied during the experiment from 1 to 3 g_{OTS} l

$^{-1}$ d^{-1} and it was noticed that the biogas production varied from 620.12 – 1071.55 l/kg$_{OTS}$.day with 1g $_{OTS}$ l $^{-1}$ d^{-1}, 888.06-1643.63 l/kg$_{OTS}$.day with 1.5 g $_{OTS}$ l $^{-1}$ d^{-1}, 902.23 -985.78 l/kg$_{OTS}$.day with 2 g$_{OTS}$ l $^{-1}$ d^{-1}, 738.01 -1087.98 l/kg$_{OTS}$.day with 2.5g$_{OTS}$ l $^{-1}$ d^{-1}, and 40.85 -1569.20 l/kg$_{OTS}$.day with 3 g $_{OTS}$ l $^{-1}$ d^{-1} ,respectively.

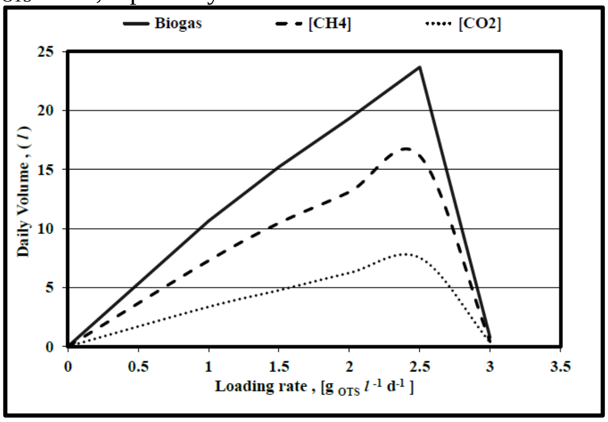


Fig. 3. The average daily production related to the loading rate.

The daily biogas and methane production related to OTS (as shown in Fig. 4) were characterized by an increasing trend with every increase of loading rate with a subsequent stabilization afterward until observed a strict decrease in methane yield with continuing feeding the reactor, from 759.24 l/kg$_{OTS}$ feed to537.59 l/kg$_{OTS}$ feed, this is consistent with Xie *et al*., (2017) who found that increasing OLR causing improved biogas production until it reached a plateau, but after this, the system started to break down as a result of the washout of the bacteria.This result is comparable to another research by Martín *et al*., (2010) who digested a food oil waste with urban solid waste and produced 550 l/kg$_{OTS}$.

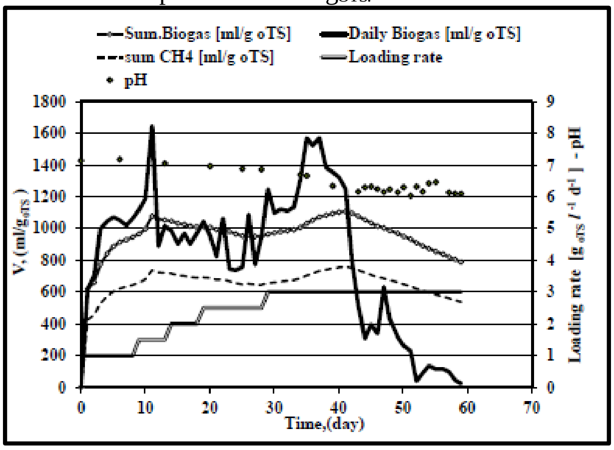


Fig. 4. Biogas and methane production l/kg$_{ots}$ with loading rate.

From Fig. 3, the biogas and methane production were characterized by an increasing trend with every loading rate with subsequent stability afterward, the biogas and methane production were somewhat stable with the stable feeding rates. At the same time, increase OLR more than optimal leads to an increase in volatile fatty acids (VFA) concentrations and ultimately decrease the pH level in the digester. This concurs with Sun *et al*., (2014) found that increasing the lipids percentage in the feeding of digester results in a concomitant increase in VFA led to lower degradation rates.

The highest biogas production was observed on the thirty-fifth day, reporting a gas production of 47 l/day with methane content 69.19% when the loading rate was 3 g $_{OTS}$ l^{-1} d^{-1}.

From Fig. (4), it was observed that the fermentation rate is in line with the loading rate and at the same time, the shape of the curve obtained indicates that with every loading rate it is required an adaptation period because of the complex composition of the oil.

Furthermore, it was observed an instabilities at different times as it appeared on the 25 and 37 day from the experiment. This behavior draws attention to the relevance of testing the digestion process using a daily fed reactor, whereas a higher oil loading rate would probably lead to depression or failure of the digestion.

The considerable variations observed on daily biogas yield (the difference sometimes reaches 25%) might be explained by the minor differences between the daily loading rate and the needed stable condition to microorganism.

After some time with using the same loading rate, the production was starting in decreased, it can be considered that the inoculum back to its endogenous activity when the production became very low. In other words, the reaction is mostly over, meaning the organic matter added was discarded.

Given the outlined in the previous paragraph, it is quite predictable that the manipulation of OLR can be used as the main tool to manage microbial communities in the digester, whereas each loading causes shock and makes a different change in microbial society. And this makes the digester more resilient to any future shocking to a different extent. From the curve, it can be seen that at the second shock loadings, there the reactor became quicker recovery to stability. This finding makes the biogas operators more flexibility and the process became optimization with effluents loaded with high organics as oil substrate. Optimization of OLR setups is therefore pivotal to the success of the anaerobic digestion process.

TS and OTS content

As can be seen from Fig. 5, which plots TS and OTS of digested substrate versus loading rate. Samples were always withdrawal from digester previous to the loading process for TS and OTS content analysis, whereas its values indicate the anaerobic fermentation success.

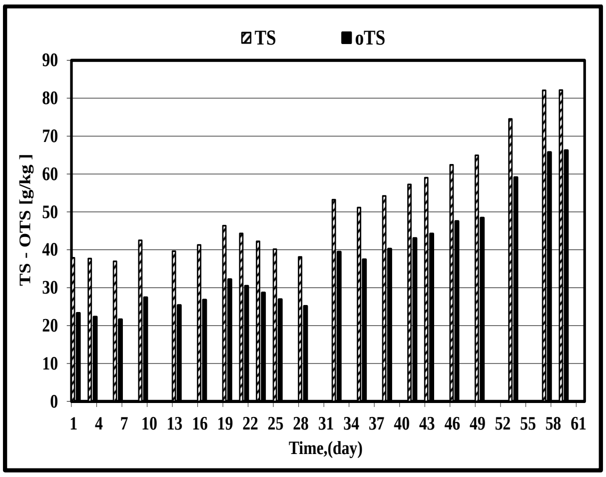


Fig. 5. TS and OTS of digested substrate versus loading rate.

Also, it can be seen that the TS and OTS values of withdrawn substrate increase intraday with every increase in loading rate then starting in decreasing which meaning the digester condition became more stabilization and successful.

On the other side, the continue to increase the loading rate lead to prevent substrate accessibility and transport across the cell walls of the microorganism and this subsequently reduces the production of methane as can be seen in Figs 3 and 4, so the values of withdrawn substrate starting increasing , which indicate the process failed as seen in Fig 5.

Organic composition

Every Organics material divided into proteins, fats, carbohydrates, and as it is known each component has a different biomethane potential so the theoretical biochemical methane potential (BMP) can be predicted when the organic component analysis.

The theoretical BMP of canola oil is 1014 mL-CH_4/gVS added depend on Buswell formula cited by Karthikeyan and Visvanathan, (2013). The theoretical BMP accounting based on assumed 100% organics degradation into methane which in practice is not really practical.

Undoubtedly, the potential yields are the primary indicator of the production of methane as well as give an idea of how successful this substrate to gain significant yield. The measurements and calculated values during the experiment are summarized in Fig. 6.

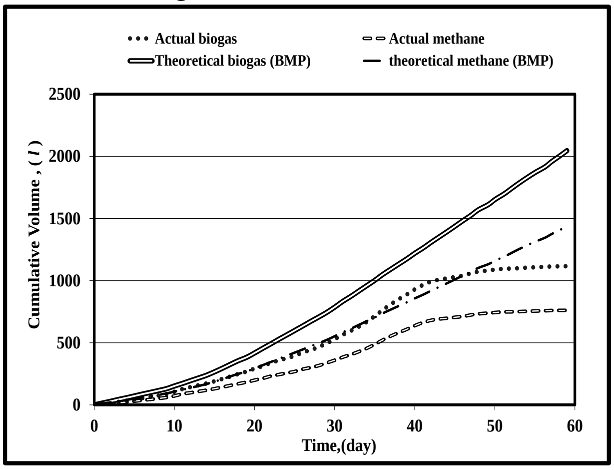


Fig. 6. the theoretical and actual of cumulative production.

The results show that the actual production was asymptotic to theoretical biochemical potential until the system started on failing after 42 days of fermentation, here the variation between the expected and actual production starting in increasing, which meaning decreasing the degradation level.

Effect of pH

As it's known that the optimal pH range for the performance of methanogens is 6.5 to 7.5. As reviewed by Lay *et al*., (1997) recommended an ideal pH range of 6.6 to 7.8 for mixed culture digestion and warned against the process failed with a pH below 6.1 or above 8.3.

From figure 4 it can be seen that the pH range was at the accepted level even with an increase in the loading rate and the production increase also until 42 day of the experiment the production starring in decreasing as an indicator to failure and this linked with decrease the PH to 6.

It is quite predictable that the conversation of lipids to VFAs through rapid hydrolysis stage is one risk faced using oil as a substrate during anaerobic digestion and affects process pH badly, whereas the rapid accumulation of VFA causes acidification also influence on the internal metabolic of the microorganisms. This matches with Rashama *et al*., (2019) who reported that increasing the OLR to high level leads to the washout of the bacteria, process failure and reduces pH, this may be inhibited methanogenic growth and activity in the digester.

Foaming

Digester foaming is an unwanted condition that results in inactive gas recovery; makes dead zones, and decrease the active volume of the digester .They further observed that biogas production be minimum when the foam is high compared to low foaming.

The foam formation was observed during the operation after 40 days of fermentation of although the good stirring but the microorganism need more adaptation period with high VFA concentration. On other words using canola oil as a substrate in digestion systems, the system may be faced a further complicated, whereas the presence of fat meaning a high tendency to float. This is in agreement with Regueiro *et al*., (2012) who observed an improvement in the biogas yield as a result of using a lipid-rich waste as substrate but it should also consider, that the use of lipid-rich wastes may present several operational problems, such as biomass flotation, clogging, and foam formation.

The calorific value and energy generation

Unquestionably, methane is a valuable component if biogas used as fuel, whereas it is the only component in biogas that has the ability to participate in a combustion process.

Depending on the production of biogas and methane both calorific value and electricity generation have been estimated, so it is quite predictable the suitable application of methane, which can be selected based on the production. Fig. 7 presents the calorific value and energy generation which can be gained from the biogas yield from canola oil. The calorific value average was 23.71 while the energy generation average was 38.62 W·h calculated based on the actual production.

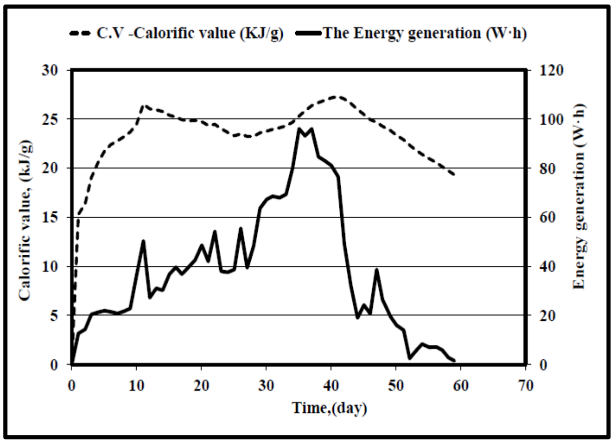


Fig. 7. Calorific and energy values during the experiment.

Comparison between using canola oil as biodiesel vs biogas

Several publications have appeared in recent years documenting using canola oil and its derivatives as a biodiesel source. However, no attention has given to using the oil as a biogas substrate.

One of the main objectives of this study is to evaluate using canola oil as a biogas source through the anaerobic digestion process and compared it with using it as a source of biodiesel. For a comparison between both kinds of biomass, all different points are summarized in Table2.

Table 2. .Energy conservation of canola oil as a source of biodiesel vs biogas

Item	Biogas	Biodiesel
Canola yield	The average canola yield was 2144.4 kg per hectare [a]	
Utilization	Heating; lighting and it is optimal for generation of electric or combined heat and power	Most promising alternative fuel for diesel engines.
Process	Anaerobic digestion	Transesterification
Greenhouse gases	60-80% less GHG than gasoline	42% less GHG than gasoline
Calorific value	23.71 MJ/kg	39.49 MJ/kg [b]
Energy Analysis	Total energy for canola seed cultivation10485.04 MJ/ha [a]	
	Energy consumed for extraction of crude canola and refining it into refined oil 2723.39 MJ/ha and 278.77 MJ/ha respectively [a]	
	Process energy demand for digestion (heating-stirring,… etc.) ≈ 8000 MJ/ha [c]	Energy consumed for convert the refined oil to biofuel ≈ 6197.32 MJ/ha [a]
	Methane yield ≈ 525.80 l/kg Range of estimated energy per hectare ≈ 1127518.165 l/ ha-1127.60 $m^3 . ha^{-1}$	Range of biodiesel production was 806.29 l/ha and became 213.39 l only after removal the energy consumed in production processes. [a]
	The total energy output of canola methane yield ≈ 41000 MJ/ ha	The total output energy is 26768.97 MJ/ha. [a] The net biodiesel energy was 7084.45 MJ/ha [a]
	Output /Input energy ≈ 1.9	Output/Input energy ≈ 1.3

[a] Reported by Ozturk , (2014)
[b] Recorded by Şahin and Aydın, (2018)
[c] Recorded by Murphy *et al*.,(2011)

CONCLUSION

This study was carried out to know the potential degradation of the canola oil substrate.The energy results were compared with other studies done for using canola oil as a source of biodiesel energy.

Canola oil as a substrate of anaerobic digestion showed a high methane production and degradation rate.The system shows a stable condition ,the highest biogas production was 47 l/day with methane content 69.19% when the loading rate was 3 $g_{OTS}\ l^{-1} d^{-1}$ with no accumulation of volatile fatty acids and constant pH, but with increasing OLR , the production and pH level starting decreasing as an indicator to increase the volatile fatty acids.

This paper attempted to conduct a detailed survey of the canola oil as substrates for AD systems. A number of ideas can be drawn for future utilize in new transactions with canola oil or related substrates.

The opportunities and challenges detected in this study could also be exploited in the day-to-day operation troubleshooting and procedure of AD processes handling canola oil or related substrates. The following are the master findings from this experiment.

1. Canola oil must be experimented separately as a substrate at anaerobic digestion to establish stander suitable operating conditions with oils, whereas echo-studies may be consulted as a beginning point for such substrate studies.
2. Operational challenges with lipid-based substrates for digestion are clogging, foaming, and biomass washout which is predominantly can be resolved through the adoption of mechanical agitation systems as well as decrease loading rates.
3. Output /Input energy ≈ 1.9 when canola oil used as biogas source while the ratio be ≈ 1.3 if canola oil used as biodiesel source
4. Future research in the future should also interest in foam and toxicity issues related to the anaerobic digestion of lipid-based wastes.

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استعادة الطاقة الحيوية من زيت الكانولا ومياه الصرف كركائز مشتركة

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زاد الاهتمام بالطاقة المتجددة نتيجة لتفاقم مشاكل أمن الطاقة العالمية ، تغير المناخ وكذلك التلوث البيئي ، لذلك لوحظ ارتفاع معدلات تطبيقات الطاقة المتجددة بشكل تدريجي على مر السنين. من الشائع استخدام زيت الكانولا كمصدر للطاقة من خلال عملية الأسترة لانتاج البيوديزل ولكن لم يستخدم كمصدر لانتاج البيوجاز من قبل ومن هنا يهدف هذا البحث إلى تقدير جدوى استخدام زيت الكانولا مع مياه الصرف من خلال التكنولوجيا البيولوجية حيث يحفز استخدام زيت الكانولا انتاج عالى من الميثان لانة مصدر زيتى ولكن هذا لا يحدث بدون معوقات كتكوين الرغوة والميل إلى تعويم الماده الدهنية وزياده الماده العضوية بدرجة كبيرة والذى يجعل الهضم أكثر صعوبة وتعقيدًا. ويهدف هذا البحث الى: (1) التحقيق في فرص الهضم اللاهوائي المتعلق بزيت الكانولا من خلال تحليل العوامل التي تؤثر على الهضم اللاهوائي كمعدلات تحميل عضوية مختلفة .(2) استكشاف إمكانيات الميثان الحيوي مقارنة بالديزل الحيوي من زيت الكانولا.؛ (3) خفض تكلفة زيت الكانولا عن طريق زيادة كفاءة الاستخدام لتوليد الطاقة. ولهذا الغرض ، تم هضم زيت الكانولا بمياه الصرف من مصنع الغاز الحيوي القديم بمعدلات تحميل مختلفة وتم استخدام مخمر من النوع ذو التغذية المستمرة (CSTR) لعملية الهضم اللاهوائي ، وأجريت التجربة لمدة 60 يومًا عند 37 درجة مئوية. وتم تقييم ظروف هضم واستقرار النظام والتأثير على الكفاءة التشغيلية الكلية اعتمادًا على خصائص زيت الكانولا. وقد كانت أهم نتائج البحث كتالى:(1) إنتاج الغاز الحيوي يتراوح بين 1569.20-620.12 لتر / كجم ، اعتمادًا على معدلات التحميل المختلفة والتى تراوحت فى التجربة ما بين 1-3 جرام/لتر يوم. (2) أعلى إنتاج للغاز الحيوي بلغ 47 لتر / يوم مع محتوى الميثان 69.19٪ و معدل التحميل 3 جرام/لتر يوم. بينما مع الثبات على نفس معدل التحميل أزداد تراكم الأحماض الدهنية داخل المخمر مما ادى الى انخفاض الأس الهيدروجيني ثم انهيارفى انتاج البيوجاز والميثان. (3) بلغت نسبة الطاقة الإنتاجية / الطاقة المستهلكة إلى 1.9% إذا تم استخدام زيت الكانولا كركيزة للغاز الحيوي بينما كانت 1.3% فقط عند استخدام زيت الكانولا كمصدر للديزل الحيوي.