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Extraction and Characterization of Biofuel from Industrial Waste organic Pupae-Silkworm

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Abstract: ***The current work carted out of analysis on the production of fuel from pupae fat extracted from silkworm, and exhaustive investigations were conducted to determine the characteristics of obtained fuel and its blends. The oily organic compounds derived from silkworm is effectively adopted to produce biofuel. The soxhlet extractor is utilized here to separate the oil content from pupae and obtained oil processed into biofuel by undertaking the transesterification process using NaOH as a fast reactive agent along with methanol. The rate of biofuel derived from pupae oil has been noticed to be 65- 70 by vol%. The extracted fuels from the transesterification process were mixed with high-speed diesel at a rate of B10, B20, B30 and B40 on volume base. The most important physical and chemical characteristics of generated fuel and their mixture with conventional diesel were examined. The investigation results reveal that the fuel sample B20 satisfies all the requirements of ASTM standards. Pure biofuel shows that the lesser heating value, higher KV, flash point, fire point and density than that of conventional diesel. The blended samples reveal that all the properties are keep moving towards higher value with an increasing percentage of biofuel presence except calorific value. Finally results in evidence that, well suitable biofuel can be generated from organic waste material like silkworm and effectively use it in practical applications.***

Keywords: ***Blends, Pupae, Silkworm, Soxhlet Extractor***

I. INTRODUCTION

Higher rate human density, rapid movement of conventional fuel towards exhaust, improper waste management strategies, dangerous gas emissions from engines and continuous rise in fuel price in the market has attracted the interest of research scholars in search of a solution [1,2]. Many researchers have identified the various biomass resources, and they proved that well promising supplement energy could be obtained from them. The group of alcohols, oils extracted from vegetables, biofuel from verities of edible and non-edible fatty oils, biogas are the most popular alternative energy sources. The obtained biofuels successfully tested in SI and CI engines respectively with or without any major alteration in the construction of engines. In the group of all these supplement sources, biodiesel gain its own popularity because of its easy production method, favourite ranges of its properties, clean-burning ability in the engine cylinder, marginal power output from engines, lesser exhaust emissions and well soluble with diesel fuel. Various biofuels separated from verities of resources like sunflower, castor seeds, pongamia seeds, cotton seeds, cashew shell, groundnuts, mustard oil, rice bran, milk skum, waste cooking oil, neem seeds, palm and orange have been utilised in CI engine with or after left out any alterations [3,5]. The characteristics such as biodegradable and non-biodegradable will segregate the feedstock's into different groups for the extraction of biodiesel. Some of the feedstock get generated and accumulated in nature as a waste for a prolonged period and leads to serious environmental problems. In this concern, plastics and used tyres receive much attention to waste management [4]. A suitable waste management technology is needed to bring out for sustainable development of a country like India. The well-established chemical process called pyrolysis process to address the single solution for two different problems. Adoption of the pyrolysis process to convert waste plastics and used tyre into fuel compounds can supply fuels for engines and reduces the quantity of non-biodegradable wastes in nature [6,7]. The biodegradable waste exhaust from the various company is disposing of in an improper method such as silkworms from silk factories, acid oil from vegetable refineries, and molasses from sugar industries and waste chicken skin from meat stalls [15]. The non-technical dispose method of biodegradable waste products may become a primary reason for spreading dangerous diseases and lousy smell all around the surrounding [8]. The effective and efficient technical process needs to be developed to minimise or convert into a useful product under the theme of waste to value-added products with least capital investment. Establishment of small scale waste processing industries can create employment locally and gives a stable solution for conventional fuel depletion as well as makes us independent from crude oil import from foreign countries and save the bulk amount of revenue [9].

A. Work carried out

Current job carried out to generate biofuels from pupae or silkworm, which can be considered as biodegradable exhaust byproduct from silk factory as waste. Time being this kind of waste Byproducts gets degraded with the actions of enzymes and bacteria which may further become a reason for spreading diseases and bad smell [10].

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To process into biofuel, the pupae need to be undergone with soxhlet extraction process to separate fatty oil from pupae. Before the soxhlet extraction process, pupae were dried in sunlight and made it as a powder to conduct the soxhlet extraction process [11,12].

The chemical agent, namely hexane, was used as a solvent to spill out the oily organic fat from powdered pupae. The obtained oil underwent through transesterification process to process into biofuel with the help of KOH as a reactive catalyst and methanol as a chemical agent. Transesterification is an efficient chemical method to generate biofuels from different fatty oils. Extracted fuels characteristics were determined by using the facilities available in our fuel test laboratory.

II. SOURCES AND METHODOLOGY

The primary sources required to produce biofuels were collected from the silk factory situated near Mangalore. The bottom line literature survey was carted out to estimate the quantity of byproducts generation from the silk factory. Silk factories will work on a seasonal base at the time of cocoons available to extract the silk thread. An average of 65 to 70 kg of silkworm obtain from 100 kilograms of cocoons, only lesser weight of silk will be available due silkworm weights more than that of silk thread. At most get successfully arranged the required quantity of silk factory at free of cost figure1 shown dry pupae and its dry powder.

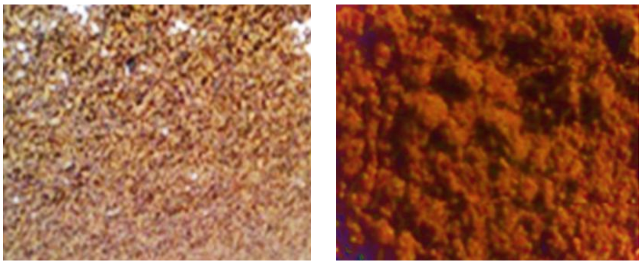

Figure 1: Dry pupae and powdered pupae

A. *Fat extraction*

The soxhlet extractor was fabricated for the capacity of 1 kg of the sample at a time. The powdered pupae sample in a paper bag is placed into the sample tank in a fabricated soxhlet extractor. The chemical agent hexane was used as a solvent; the hexane is heated to a temperature range between 60 to 65ºC for an average duration of 150 minutes. The arrangement of soxhlet extractor exhibits in figure 2. The combined solution of hexane and pupae oil collected in the solvent tank, the combined solution undergone through the distillation process to separate pupae oil and hexane at the temperature range 70-75ºC for 120 minutes. Liquid hexane will get evaporate and get condensed at the section of condenser provided in the soxhlet extractor. Due to boiling point difference between pupae oil and hexane, after evaporation of hexane solution oil will get settled in distillation tank. The arrangement of solvent separation and obtained pupae oil shows in figure 3.

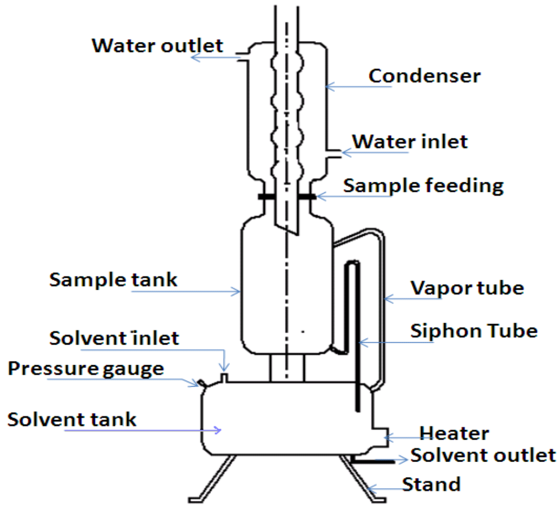

Figure 2: Soxhlet extractor

Figure 3. Solvent extraction and pupae oil

B. *Conversion of pupae oil into biofuel*

The pupae oil processed into biofuel carrying out with the help of single-stage catalytic transesterification process. Transesterification process carted out with magnetic stirrer with heater, round bottom container, methanol and NaOH as an active catalyst. 1000 ml of a scaled quantity fatty organic oil obtained from pupae was taken in a round bottom container and heated to the temperature 70ºC for 60 minutes duration to remove water content, unwanted impurities etc. The conversion process carried out by varying the quantity of NaOH as well as methanol to analyse the feasibility of the transesterification process. The amount of reactive agent NaOH and methanol used at the rate of between 2.5 to 5gm and 220 to 250ml. The mixture of NaOH and methanol is added to heated pupae oil and maintained the temperature between 60 to 80ºC about 120 minutes. The mixture of methoxide and pupae oil allowed to cool down for about one hour. The sample gets separated and formed two different layers as biofuel and glycerin, as shown in figure 4.

Figure 4. Methoxide, Transesterification process and Biofuel

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III. RESULT AND DISCUSSION

The transesterification process has been carted to pre-treated pupae oil to generate efficient biofuel with the presence of reactive agent and methanol. The conversion process could not be conducted if the free fatty acid value is higher than 4%. The FFA were determined by adopting titration method and found that oil extracted from pupae is secured with 8.31%, a higher amount of FFA influence on transesterification reaction time and quantity of biofuel yield, acid wash process was carried out to bring down the value of FFA to lesser than 4%. The concentration of catalyst and methanol effects the investigations on the quantity of biodiesel yield are noticed, and the results are summarized in table I. The amount of catalyst concentration affects the reaction time, yield and formation of byproduct such as glycerin were observed.

Table I: Biofuel yield with catalyst concentration

NaOH (gm)	Methanol (ml)	Biofuel yield (ml)	Glycerine (ml)	Methanol
2.5	220	540-560	360-370	---
3	230	540-560	360-370	---
3.5	240	630- 650	280-310	---
4	250	580-610	330-340	---
4.5	260	630-670	270-310	---
5	270	530-580	350-370	---

Exhaustive investigations were conducted to determine the different characteristics of produced biofuel and its blends Table II: Characteristics of biofuel and its mixtures with conventional diesel fuel. The combinations were prepared on volume base namely B10, B20, B30 and B40; all the combinations were undertaken to accomplish flashpoint, fire point, density, viscosity, calorific value and iodine value, saponification value, FFA, and cetane number. Experimental results indicate that for pure biofuel, lower the calorific value, higher range of density, specific gravity, KV, flash and fire point. When biofuel mixed with conventional diesel, results reveal that the percentage of produced biofuel increases with mixtures increases all the respective properties except primarily required properties such as calorific value because of produced fuel secured with lesser value than the diesel fuel.

Properties	Pupae oil	B100	B10	B20	B30	B40	B0
Density kg/m3	898.26	867.6	843.8	846.9	849.7	854.3	832.6
Specific gravity	963	913	823	834	843	851	820
Kinematic Viscosity(c.St)	35.63	4.79	3.98	4.19.	4.23	4.39	3.97
Calorific Value(MJ/Kg)	---	38.67	41.57	40.19	39.75	38.53	44.7
Flash Point (^{0}C)	231	113	80	95	108	115	53
Fire point (^{0}C)	249	135	94	109	113	123	59
Cetane Number	----	57.85	---	---	---	---	---
FFA, NaOH(g/ltr)	8.31	---	---	---	---	---	---
Saponification Value	128.42	---	---	---	---	---	---
Iodine Value	119.12	---	---	---	---	---	---

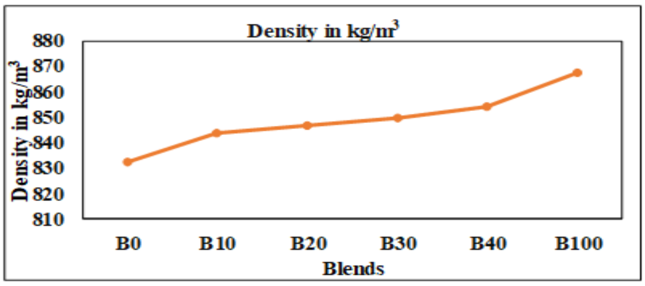

Figure 5. Variation of density with blends percentage

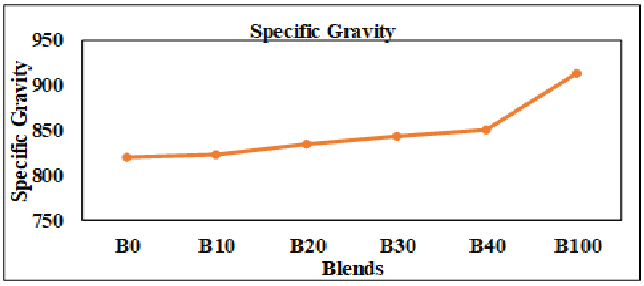

Figure 7. Variation of kinematic viscosity with blends percentage

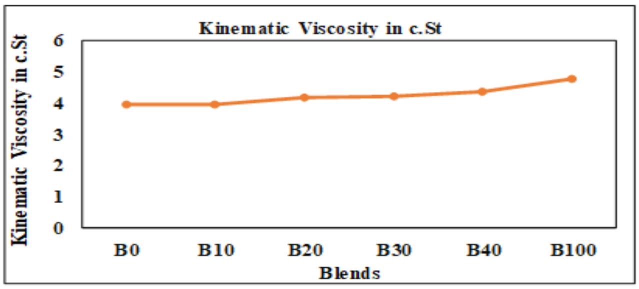

Figure 6. Variation of specific gravity with blends percentage

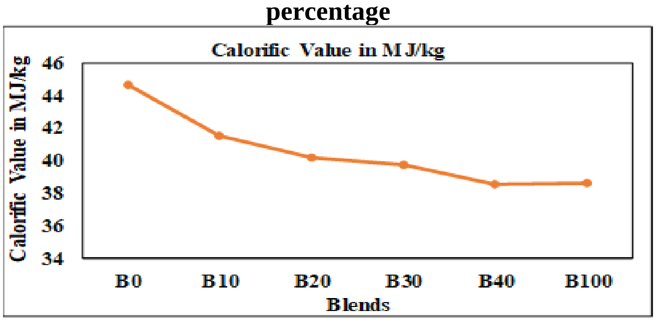

Figure 8. Variation of calorific value with blends percentage

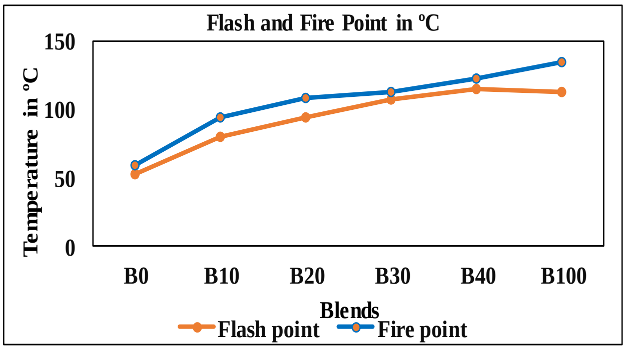

Figure 9. Variation of flashpoint and fire point with blends percentage

Figure 5 to 9 showcase that the variations in all respective properties of biofuel and its combinations with high-speed diesel. Raw biofuel expresses less quantity of calorific value, higher flash point, fire point and kinematic viscosity than diesel. To use more top viscous fuel in CI engine, fuel supply and injection systems needs to be altered, which may further induce additional capital investment. If fuels prepared in combination mode can be left out all alteration with CI engine because combined samples indicate that all the properties meet ASTM standards.

IV. CONCLUSION

Right now, biofuels are only feasible alteration to conventional hydrocarbon transportation energy sources. The essential features of biofuels can use existing CI engines with or without any extensive changes. This is their most extended benefits as concerns about environmental impacts. Biofuels furnish a better efficient and cheapest alternative energy sources to foreign fuel imports. The biofuels are usually centered around the fact that they are derived from agricultural products. If the efficient technology developed to the extraction of biofuels from waste byproduct from many industries will furnish the more significant changes in waste management, waste to value-added products and reduces the transportation cost. The experimental results conclude that waste pupae can be well suitable resources to extract useful energy tanks for diesel vehicles. Extraction process reveals that the concentration of catalyst and methanol affects the rate of fuel yield and trail carted out by using 4.5 gm of catalyst and 260ml of methanol generates a higher quantity of biofuel. The characteristics of different fuel combinations of pupae biofuel and diesel are very closer to conventional diesel. All these experimental results conclude pupae has all kind of potential to become an alternative feedstock to generate supplements fuels for CI engines. Establishment of small scale industries to carry out the conversion of waste byproducts into value-added products can create considerable employment locally.

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AUTHORS PROFILE

RAVIKUMAR R, BE, M. Tech, (PhD), He has published 9 international peer reviewed research articles, perusing research work on alternative fuels and internal combustion engines, a lifetime member of ISME, Fund received from Govt and non Govt agencies worth of 3 lacks. His ambition is to bring out better efficient alternative biofuel for IC engines in terms of better performance and lower emissions. Currently, He and his team working on engine combustion by utilizing biofuels derived from various waste sources such as waste plastics, used tyres, chicken waste skin, pig waste etc. by simulation as well as experimental methods. The engine will be operated by varying compression ratio, speed, load with different blends of derived fuels and conventional diesel.

HARISH KUMAR M, BE, M.Tech, (PhD), He started his career as CAD Designer at YOKOGAWA INDIA LIMITED. He joined as an Assistant Professor in the Department of Automobile Engineering at Oxford College of Engineering and presently Working as Assistant Professor, Department of Mechanical and Automobile Engineering, CHRIST (Deemed to be university), Bangalore. His research interests include impact characterization and machining effects on composite laminates, alternative fuels and internal combustion engines. Mr Harish has published 2 papers in reputed peer reviewed journals and international conferences. He is also member of many professional bodies. He is the faculty advisor of Team MEDUSO Racing (Shell Eco Marathon), Team Zephyrus Racing (SUPRA SAEINDIA) and Team POLLUX (REEV) the racing car team of CHRIST (Deemed to be university).

KIRAN K, BE, M.Tech, (PhD), He is working on Energy and Alternative fuels from past few years. He has the experience of handling funded projects worth 1 crore from government and other recognised bodies. Currently, he involved in design and fabrication of reactors specifically designed to meet biofuel requirements. At present, involved in research on Biofuels from Algae, waste cooked oil. Process optimization of pond grown algae into biodiesel and its performance and pollution characteristics using a research engine is an ongoing project funded by the University. Few other biodiesels are also being experimented with different blending option. Ethanol from bamboo stems is another project at present. He has published around 20 peer reviewed research articles and presented research outcomes in national and international platform.

Dr. GURUMOORTY S HEBBAR, BE, M.Tech, PhD. His research area is in diesel and alternative fuel engine focused on combustion and pollution control aspects. At present, involved in research on Biofuels from Algae, waste cooked oil. Process optimization of pond grown algae into biodiesel and its performance and pollution characteristics using a research engine is an ongoing project funded by the University. Few other biodiesels are also being experimented with different blending option. Ethanol from bamboo stems is another project at present. Bamboo powdering and reactor designs are customized by our own research team. I am also involved in a project on energy management of Hybrid Vehicle.