Int. J. Mech. Eng. & Rob. Res. 2014

International Journal of Mechanical Engineering and Robotics Research

ISSN 2278 – 0149 www.ijmerr.com
Vol. 3, No. 2, April, 2014

Research Paper

MELON SEED OIL AS BIO FUEL

S Sri Krishna[1]*, M Uma Mahesh Babu[1], M.Yaswanth Raja[1]

**Corresponding Author: S Sri Krishna,* ✉ *srikrishna.sure@gmail.com*

Biodiesel, the name popularly given to fatty acid alkyl esters, has become an attractive option for the replacement of petroleum diesel ('petrodiesel'). Biodiesel is biodegradable, generally non-toxic and has superior lubricity to petrodiesel. Dried melon seeds (Citrullus colocynthis L.) of the family Cucurbitaceae were investigated for nutritional quality and the oil seed characteristics. These melon seeds, on a dry weight basis, consisted of 52.3% of testa and 47.7% of kernel. The moisture content in melon seeds was 54.5% and the mineral constituents were also determined. The oil content of seeds was very high, ranging from 22.1-53.5%, due to the presence of the hulls, 22% from the seeds and 53% of the kernel, and also the crude protein content was so high as the 21.8% of the seeds. Oil from Melon seed was extracted using methanol and converted to biodiesel by sodium methoxide catalyst at thereaction temperature of 600c or the duration of one hour. This process is called Transesterification. The fuel properties of the melon seed biodiesel compared with the conventional petrol diesel showed that biodiesel from melon seed oil could be used alone or in blends with petrol- diesel to power compression diesel engines.

Keywords: Petrodiesel, Cucurbitaceae, Melon seed, Sodium methoxide catalyst, Transesterification

INTRODUCTION

In 1900, an early diesel engine was operated on peanut oil with apparently excellent results. Since that time, the requirements for an alternative internal combustion engine fuel have grown increasingly more stringent. Whereas, in earlier years, it was sufficient for a fuel tomerely provide enough energy and impetus to get the engine running, now the fuel must also be non-toxic, bebiodegradable, come from renewable sources and minimize emissions of CO, NOx, unburned hydrocarbons and CO2. The process biodiesel production from fat is not a new process, it was discovered as early as 1853, when scientists Duffy and Patrick conducted the first Transesterification of a vegetable oil, many years before the first diesel engine became functional. Transesterification is a process of using an alcohol, such as ethanol or methanol in sodium hydroxide or potassium hydroxide, to chemically break the molecule of the raw renewable oil with glycerol as a By-product (Gerpen, 2005).The increase in population of both the developing and developed nations of the world are the consequence which increase the fuel consumption and the non

[1] Sri Venkateswara Institute of Science and Technology, Tadigutla, Pulivendula Road, C.K. Dinne Mandal, Kadapa. Y.S.R. Dist. 516003.

renewability of diesel source (petroleum), as well as the adverse environmental effects of diesel burning are some of the factors that have made alternatives to petrol diesel very attractive. (Jaturang et al .2004). Blending cracking, pyrolysis, emulsification or Transesterification of vegetable oils to produce biodiesel may overcome these problems. Heating and blending of vegetable oil may reduce the viscosity and improve volatility of vegetable oils but the molecular structure remains unchanged, hence poly saturated character remains. Blending of vegetable oil with diesel however reduces the viscosity drastically and the fuel handling system of the engine can handle vegetable oil diesel blends without any problems. On the basis of experimental investigations, it is found that converting vegetable oils into simple esters is an effective way of overcoming all the problems associated with the vegetable oils (Srivastava and Prasad, 2004).

PREPARATION OF MELON SEEDS

The fuel source from the egusi seeds could reduce petrol cost by 20 per cent and diesel cost by 10 per cent. The difference in costs will even be greater with the rising costs of fossil fuels like petrol and diesel. The egusi seed oil has the potential to be processed into petrol and diesel for commercial use as it is lighter, harvesting of the seeds is easy and more economical compared to palm oil and jathropa, among the sources of biodiesel and the egusi oil to be low in fatty acid, melts easily and increases combustion.

Egusi (Colocynthis citrullus lanatus) is among 300 melon species found in tropical Africa. The fruit looks so much like a small, round watermelon but is not edible as its white flesh is dry and bitter enough to be repulsive. The seeds which resemble large, white melon seeds are usually eaten as a snack or used in cooking.

Figure 1: Whole Egusi Fruit Ready for Harvest

Planting, monitoring and harvesting to obtain seeds from the fruits was presented. Seeds were sun and then oven dried in line with the ASAE S 352 standards to achieve moisture content of 7.11%, and were then ground for oil extraction. Crude oil from the seeds was extracted using sohxlet extraction method with hexane as solvent.

The biodiesel qualities of the oil from both seed kernels and the whole seed were tested and conform to ASTM and EN standards. Flash points, kinematic viscosities, acid values and Cetane numbers to mention a few, were in the range of both ASTM and EN standards. Figures 1, 2 and 3 shows the whole egusi fruit, cut fruit showing seed layout and washed seeds being dried in the sun.

Figure 2: Horizontally Cut Fruit Showing Layout of Seeds in the Fruit Efore Rotting

Figure 3: Sun Drying of Seeds After Washing, Ready for Further Processing

The cut fruits were heaped for 6 days to rot so that the seeds can be free from the flesh. The free seeds were then washed with ample water to remove dirt and pre-matured seeds, and sun dried for three days Figure 3.

CHARACTERISTICS AND COMPOSITION OF MELON SEED OIL

The fatty acid profiles of the seed oil showed an unsaturated fatty acid content of 77.4% and the high content of 63.2% of PUFA. The fatty acid profile of edible oils plays an important role in their stability and nutritional value. Monounsaturates (18:1) and polyunsaturates (18:2) fatty acids have been found to be effective replacements for saturates as part of cholesterol-lowering diets (Matson ,F.H., and S.M. Grundy, 1985). However, it is also known that the oils with substantial amounts of unsaturation, particularly 18:2 fatty acids, are susceptible to oxidation and may produce products that contribute to arteriosclerosis and carcinogenesis. Some studies with experimental animals indicate that excessive amounts of linoleic acid promote carcinogenesis Watermelon seed oil, rich in linoleic acid (~64.5%), is used for frying and cooking in some African and Middle Eastern American countries owning to its unique flavor (Akoh, C.C, and C.V.Nwosu , 1992). Much research has been published on the oxidative stability of vegetable or fruit oils, but a little has been reported on the stability of melon seed oil. The modification of melon seed oil fatty acid composition by incorporation of oleic acid (18:1) has been explored (Charment, O Moussata, and C C Akoh, 1997). The modified melon seed oil was produced with the better balance of monounsaturate (18:1) and essential fatty acids (18:2), and also improved the seed oil oxidative stability and nutritional value (Chairmen, O Moussata, and C C Akoh, 1998). The watermelon, (Citrullus colocynthis L) family Cucurbitaceae is the most popular fruit in Serbia, with a traditional name ?lubenica?. Unfortunately, according to the literature data there is not any information of domestic sample, about medicinal values of the seeds or seed oil applied for cooking and frying or as useful product with good nutritional value. Thus, the seed oil composition of the domestic watermelon was evaluated in the current study, which had not been previously investigated. These data may help in the selection of melon seed oil for future commercial production in human diet.

MATERIAL AND METHODS

Melon seeds: The seeds were taken from ripened fresh samples. Moisture was determined directly on the seeds by oven drying at 1050c for 6 hours. The yield of the dry seeds from the sample was determined. The ripened seeds and dry seeds were then ground in some blender, separately, and placed in vacuum oven at 60 0 c for 6 hours and finally stored in exiccator until analyzed. Proximate analyses were performed in triplicate in accordance with the AOAC procedures (AOAC, 1975). The ash was determined by heating overnight at 500oC and the protein content of the kernels and seeds by standard Kjeldahl (total %N) procedure.

Mineral constituents: According to the standard procedure, the sample of the seeds was dry and ashed for the mineral determination. A Variant 1475 atomic absorption spectrophotometer was employed to measure Mg, Fe, Zn, Cu, Ca and K in the seeds.

Extraction: The seeds were dried at room temperature, ripened and ground in an electric blender. The samples of seeds (100g) and kernels (100g) were extracted with petroleum ether (Merck, 40-600c) using a Soxhlet apparatus for 6 hr. The extract was desolventised in vacuo on a rotary evaporator at 350c, yielding lipid samples as the residue.

PHYSICO-CHEMICAL CHARACTERISTICS OF SEED OIL SAMPLES:

The ordinary oil constants, e.g. acid value, iodine, saponification and peroxide values, specific gravity and the refractive index were estimated according to the AOCS method (Official Methods of Analysis of AOAC, 1995). The fatty acids profiles were determined by GC. The methyl esters of the fatty acid were prepared by the method of Christie (Cristie, W., 1973) and analyzed by a Hewlett Packard (Avondale, PA) 571017 gas chromatograph, fitted with a flame ionization detector. A 152.4 cm x 0.317 cm glass column packed with 10% DEGS on Chromosorb VV HP 80/100 mesh was used for the analysis. Samples were run isothermally at 190oC with injector and detector ports at 200 0c. Helium carrier gas flow was 30 mL/min. The peaks obtained, by injecting 20 ?l of methyl esters, were identified by running a standard fatty acid mixture and comparing the Rf values.

Table 1: Chemical Composition of Melon Seeds*

Total protein of seeds	21.8
Total protein of kernels	38.2
Crude oil of seeds	22.1
Crude oil of kernels	53.5
Total ash	2.9
Moisture in %	54.5

*Percent basis on a dry weight

Table 2: Mineral Constituents of Melon Seeds*

Iron	42
Calcium	1035
Zinc	39
Copper	17.8
Phosphorus	5200
Magnesium	2100
Potassium	7700

*Parts per million-mg/kg

Table 3: Physical and Chemical Characteristics of Melon Seed Oil

Specific gravity 20oC (kg/dm3)	0.914
Refractive index 20oC	1.4733
Acid value (mgKOH/g)	1.00
Saponification value (mgKOH/g)	188
Iodine value (g/100g)	119
Peroxide value (mmolO2/kg)	7.9
Unsaponifiable matter (%)	1.02
Ester number	187
Free fatty acid (% oleic acid)	0.52

TRANSESTERIFICATION

Transesterification process is a set of three consecutive chemical reactions between esters generally and mainly triglycerides and simple alcohols. The reaction is usually very slow to be of any industrial value and as such catalysts, which can be acidic, basic, organic or enzymatic, are usually used to achieve reasonable conversion at short time. Also, since the reaction is reversible as 1 mole of the triglyceride reacts with 3 moles of the alcohol, removal of one of the products or an increase in the mole ratio of one of the reactants can be used to drive the reaction to the right (alkyl ester formation).

Usually, the methanol to oil/triglyceride mole ratio is made greater than 3:1; 6:1 and above for most oils.

CH2COOR1 CH3COOR1 CH2-OH

I I

CHCOOR2 + 3CH3OH NaOH CH3COOR2 + CH-OH

I Δ→ I

CH2COOR3 CH3COOR3 CH2-OH

Typical Transesterification Reaction Equation

we report a work carried out with melon seed oil which has been identified elsewhere as possible industrial oil and proposals made as to how it could be produced to meet both the domestic and industrial needs like the case of soybean oil. Fuel properties of the fatty acid methyl esters obtained from the oil were determined and compared with that of conventional petroleum derived diesel fuel. Melon seeds were ground and extracted with 60-80°C boiling range petroleum ether and the solvent recovered using a rotary evaporator. The oil was degummed to remove phosphatides, alkali-refined to get rid of the free fatty acids, and heated to, and held at 105°C for 30 min. to expel moisture. The acid, saponification and iodine values of the freshly extracted oil were determined using ASTM methods. Methanol was a product of Merk, Darmstadt, Germany and is of 99.7% purity, while the sodium hydroxide was a product of Loba Chemie GmbH Switzerland. All other regents were of analytical grade unless otherwise stated.

Preparation of Sodium Methoxide

0.35g of NaOH was added with care into a beaker containing 40cm3 of methanol, and stirred vigorously until the NaOH dissolved completely to form sodium methoxide. The solution was heated to 60°C and held at that temperature.

Production and Purification of Biodiesel

The transesterification reaction was carried out in a three-necked 500ml round bottom flask equipped with a thermometer, condenser and stirrer. 100ml of melon seed oil was put in the flask and heated to 60°C. The catalyst solution also at 60°C was gradually introduced into the flask containing the oil. The temperature of the system was maintained at 65±2°C for 1h with the stirrer operating at 150rpm.

At the end of 1h the reaction was assumed to have reached completion and immersing the flask in a cold water bath was applied to quench the reaction. The method of Ikwuagwu et al was used to separate the biodiesel (upper layer) from the glycerol (lower layer) using a separating funnel. The biodiesel was washed with about 15% by weight of warm distilled water and about 5% NaHCO3 three times to a neutral pH to remove the catalyst, glycerol and other impurities. Rotary evaporator was used to recover completely the excess methanol in the biodiesel at the boiling temperature (67°C) of methanol. The moisture remaining in the product was removed with anhydrous Na2SO4 which was subsequently filtered off and the product dried at 105°C for 10 min, cooled and weighed. The glycerol was also purified according to the methods of De Filippis et al. The above experiments were performed in duplicate and the average values obtained.

Table 4: Some Physicochemical Properties of Raw and Refined MSO

Properties	Raw Oil	Refined Oil
Colour	Golden yellow	Golden yellow
Specific Gravity	0.9138	0.9013
Viscosity (mm2s-1)	33.29	31.02
Iodine value (mgI/g sample)	121.8	119.29
Acid value (mgKOH/g)	2.08	0.93
Saponification value	192.5	191.6
Flash Point (°C)	186	181
Heat of Combustion (kJ/g)	38.74	38.43

Table 5: Fuel Properties of the MSO-Biodiesel and Commercial Petrodiesel

Properties	MSO-Biodiesel	Petrodiesel
Colour	Clear yellow liquid	Clear liquid
Sp. Gravity	0.8786	0.8347
Viscosity (Cst)	6.24	4.43
pH	7.23	7.76
Iodine Value	115.5	76.2
Heat of Combustion	36.34	42.89
Flash Point	148	79

Melon seed oil has been used to produce methyl ester (biodiesel) and the characteristics of the product indicates that it is potential fatty oil for biodiesel production.

There is now a growing list of various industrial applications of melon seed oil.

EFFECTS OF BLENDING ON THE PROPERTIES OF BIODIESEL FUELS

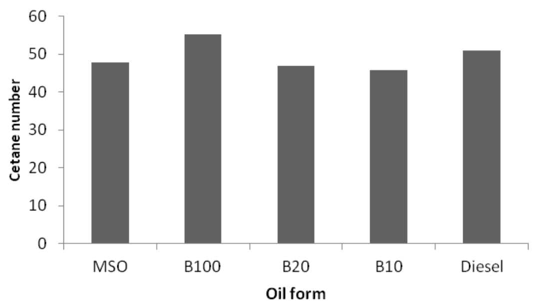
Most vegetable oils are too viscous for direct use as diesel engine fuel hence they are transesterified to biodiesel to modify their properties. Transesterification involves transformation of the molecular structure hence change in the properties The relatively high viscosity of vegetable oils and the consequential poor fuel atomization characteristic, fuel injector blockage and cold starting problems, makes them unsuitable for use in neat form as diesel engine fuel making it necessary to convert vegetable oil to esters by the method of transesterification to produce biodiesel.

CETANE NUMBER

One of the main advantages of biodiesel is the high cetane number that allows for more complete combustion and wider energy release spectrum. The results obtained shows that cetane number increases by an average of 10 to 40% after transesterification and the increase depend on the degree of unsaturation. Egusi melon oil methyl ester the most unsaturated had the lowest cetane number. Blending with diesel decreased cetane number to below that of diesel fuel for all the biodiesels. Highly unsaturated biodiesel tend to have lower cetane number increase after transesterification. They also have higher distillation temperature because they are long chained and have multiple bonds.

The proportion of the fatty acids changed between 5 to 10% after transesterification and only 1 to 2% after blending. The initial boiling point for Egusi Melon Oil Methyl Ester (EMOME) is 296°c. The distillation temperature corresponding to 50% for diesel is 260°C and for EMOME is 345 which is higher than the corresponding temperature for diesel fuel. Also blending had little effect on the cetane number. Egusi melon is 75.67% unsaturated. Cetane number tends to decrease with the amount of unsaturation of the oil. The effect of transesterification on the fatty acid profile is not very significant as transesterification is the displacement of alcohol from an ester by another alcohol (Otera,1993), although the properties may change as a result of the displacement, the net composition remain essentially unchanged. Distillation temperature is a measure of the boiling point of the fuel and affects the combustion characteristics of the fuel. When very high it can shorten the ignition delay thereby making the fuel susceptible to knock.

Figure 4: Variation of Cetane Number of Egusi Melon Seed Oil with Form



DISCUSSION

The oil yield estimation after extraction was found to be 41% and it is in the range of the standard oil yield 25 - 45%. As such melon seed oil as non-edible vegetable oil can be used as a feed stock in oil chemical industries (biodiesel, fatty acid, soap, detergent etc.).

Specific gravity has been described as one of the most basic and most important properties of fuel (Alawu et al., 2007) because of its correlation with cetane number, heating values and fuel storage and transportations (Ajab and Akingbehin 2002). The specific gravity obtained for melon seed oil lies within the standard range 0.87 - 0.9 and that of the produced biodiesel was 0.885 slightly higher than the petrodiesel standard range 0.81 - 0.86. the petro-diesel used in this study gave specific gravity of 0.857 lower than that of the melon seed oil 0.921.

Saponification values of oil are between the range of the standard 175 - 205mg KOH/g oil. It was found to be 190.04mg KOH/g oil, this high value indicates that the melon seed oil is normally triglycerides and can be used in the production of soap and shampoo. This indicates that melon seed oil biodiesel could be used in blends with petro-diesel to power compression (diesel) engines.

The fatty acid composition and characteristics of the melon seed oil obtained in our study were in general agreement with the results obtained in earlier studies, however, the levels of the linoleic acid reported ranged from 52-65%, compared to the 62.2% in the present study. The modification of the melon seed oil fatty acid by the addition of oleic acid (18:1) into seed oil provided better oxidative stability at the moderate temperature.

Blending biodiesel with diesel can be employed to increase heating value and oxidation stability. However, since diesel has flash point and cetane number less than B100, their values would be reduced by blending. Kinematic viscosity, Acid value, sulphated ash, carbon residue and corrosion are reduced.

CONCLUSION

Is there a fuel that will fill all of the requirements for an alternative transport fuel? Perhaps, in the long-term, electric vehicles that ultimately draw their energy from solar, wind and geothermal sources may be the answer but in the interim, until

existing vehicles can be replaced, a liquid fuel is necessary. Biodiesel may provide just such an interim solution. The presented data suggest that melon seeds may constitute useful product with good nutritional value. The melon seeds contain a high content of

crude protein and oil, e.g. 21% and 22% respectively. The melon kernels had especially high content: 38% of protein and 52% of oil. The physicochemical parameters of the produced biodiesel and blend biodiesel are very close to that of suitable for industrial production of biodiesel, use of petrol diesel. This shows that melon seed oil is non edible plant seeds that produced high percentage yield of oil for biodiesel production is one of the significant of this research so that the problems like global warming; environmental pollution and energy security will be addresses.

References

1. Bande Yahaya Muhammad, Adam Nor Mariah, Jamarei Bin Othman, Azmi Yahya, and Zubairu Usman Bashar (2013), "Egusi melon (Citrullus lanatus) crop–Malaysian new oil/energy source:Production, processing and prospects", Australian Journal of Crop Science, Vol. 7, No. 13, pp. 2101-2107.
2. E I Bello and F Otu (2012) "Effects of Blending on the Properties of Biodiesel Fuels", Journal of Emerging Trends in Engineering and Applied Sciences, Vol. 3, No. 3, pp. 556-562.
3. E I Bello, F Out and A Osasona (2012), "Cetane number of three vegetable oils, their biodiesels and blends with diesel fuel", Journal of Petroleum Technology and Alternative Fuels, Vol. 3, No. 5, pp. 52-57.
4. Luis F. Razon (2009), "Alternative Crops for Biodiesel Feedstock", CAN Reviews, No. 056.
5. Mirjana Milovanovic, and Ksenija Picuric-Jovanovic (2005), "Characteristics and Composition of Melon Seed Oil", Journal of Agricultural Sciences, Vol. 50, No. 1, pp. 41-47.
6. Paul Madus Ejikeme, Chinedum Anthony Cemaluk Egbounu, Ikechukwu Daniel Anyaogu and, Valentine Chinaka Eze (2011), "Fatty Acid Methyl Esters of Melon Seed Oil: Characterisation for Potential Diesel Fuel Application", Leonardo Journal of Sciences, No. 18, pp. 75-84.
7. Usman B and Bello (2013), "Production of Biodiesel from Melon Seed", IJSERT, Vol. 2, No. 2.