

FATTY ACID COMPOSITION AND PROPERTIES OF *PONGAMIA PINNATA* OIL AND ITS METHYL ESTERS FROM SOUTHERN REGION OF THAILAND

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Abstract:

Pongamia pinnata is a fast-growing leguminous tree with the potential for high oil content from seed. It can grow on stony, sandy or clayey, including verticals. It is highly tolerant of salinity and can be propagated either by seeds or by root suckers. It grows abundantly along the coasts of southern region of Thailand, especially Ranong province. It is non-edible oil because it has toxic flavonoids compounds. However, the oil contains polyunsaturated fatty acids that they are important source of biodiesel. In this study, Crude oil was extracted from seeds with hexane solvent. Chemical and physical properties of crude oil were analyzed, such as acid value, iodine value, phosphorus content, viscosity and pour point. The result of fatty acid compositions showed that oil predominantly contained 68.27% unsaturated fatty acids (Oleic acid 44.89%, Linoleic acid 17.04%, Linolenic acid 3.55% and Erucic acid 2.79%). The total saturated fatty acid was 31.73% (Palmitic acid 12.63%, Stearic acid 6.65%, Arachidic acid 1.83%, and Behenic acid 10.62%). *Pongamia pinnata* oil was further studied to biodiesel by transesterification reaction. The yield of methyl esters was 78.26%. The preliminary physico-chemical characteristics relating to fuel properties of methyl esters were analyzed and followed up ASTM standard. The results showed that the characteristics of methyl esters from *Pongamia pinnata* oil met the standard for biodiesel suggesting its possible new source of biodiesel production in the future of Thailand

Introduction:

Pongamia pinnata belongs to the family Leguminaceae. It is a medium sized glabrous tree that generally attains a height of about 18 m and a trunk diameter >50 cm. It can grow under a wide range of agroclimatic condition and is a common sight around coastal areas, riverbanks tidal forests and roadsides. It can grow on most soil types ranging from stony to sandy to clayey, including verticals. It is highly tolerant of salinity and can be propagated either by seeds or by root suckers. In Thailand, it is commonly known as Hye Nam or Hye Talay. After 5-7 years of growth it bears fruits containing one to two kidney-shaped brownish-red kernels. It is one of the few nitrogen-fixing tree producing seed kernels containing 18-27% oil. Freshly extracted oil is yellowish orange to brown in colour having a disagreeable odour and a bitter taste. The presence of toxic flavonoids such as karanjin, pongapin and pon paglubrin make the oil inedible. *Pongamia pinnata* oil is regarded as a potential fuel substitute that it contains 16-22 carbon atoms per molecule. Attempts have been made for the conversion of *Pongamia pinnata* oil to methyl esters or biodiesel.

Objective:

This work is to study oil content, chemical properties, fatty acid composition, chemical, physical and fuel fuel properties of methyl esters product from the oil of *Pongamia pinnata*.

1. Materials:



2. Experiment:



Figure 1 Raw materials and steps of experiment

3. Analytical method:

- Physical properties of oil (Acid value, Pour point, Iodine value, viscosity, phosphorus content, density) are determined follow AOCS standard method.
- Fatty acid composition is determined by GC.
- Tocopherols and tocotrienols content are determined by HPLC.
- Fuel properties of biodiesel are determined follow ASTM standard method.

Results and Discussion :

The yield of extracted oil by hexane was 25.32 mass% of the dry original seed kernel weight. The crude oil obtained was brownish in appearance. The physical properties of *Pongamia pinnata* crude oil was shown in table 1. The fatty acid composition of the oil given in table 2 was relatively calculated from peak areas of GC chromatogram.

Table 1 Physical properties of *Pongamia pinnata* crude oil

Properties	Value
MWcalc. g/mol	893
Pour Point, °C	11.50
Kinematic viscosity at 40°C, cSt	36.10
Acid value, mg KOH/g	4.08
Iodine value, g I ₂ /100 g	74.01
Phosphorus content, ppm	234.92

Table 2 Fatty acid compositions (area %) of crude oil

Fatty acid	Retention time (min)	%
Palmitic acid (16:0)	12.519	12.63
Stearic acid (18:0)	14.278	6.65
Oleic acid (18:1)	14.465	44.89
Linoleic acid (18:2)	14.852	17.04
Linolenic acid (18:3)	15.388	3.55
Arachidic acid (20:0)	16.073	1.83
Behenic acid (22:0)	17.427	10.62
Erucic acid (22:1)	18.931	2.79
Σ Sat ^a	-	31.73
Σ Monounsatur ^b	-	47.68
Σ Polyunsatur ^c	-	20.59

^a Σ Sat^a = C16:0 + C18:0 + C20:0 + C22:0
^b Σ Monounsatur^b = C18:1 + C22:1
^c Σ Polyunsatur^c = C18:2 + C18:3

GC chromatogram of *Pongamia Pinnata* oil methyl esters

Pongamia pinnata oil from southern region of Thailand consist of a larger amount of monounsaturated fatty acids (47.68%) than polyunsaturated fatty acids (20.59%), so this oil is suitable for biodiesel feedstock. The results of tocopherols and tocotrienols content in *Pongamia pinnata* oil were quantified from chromatogram and the amount was shown in Table 3

Table 3 The amount of tocopherols and tocotrienols in *Pongamia pinnata* oil

Compound	Amount (ppm)
α-tocopherol	1384.86
α-tocotrienol	1115.85
δ-tocotrienol	19746.32
γ-tocopherol	4208.78
γ-tocotrienol	658.64

The total content of both tocopherols and tocotrienol was 27114.45 ppm that indicated the oil has high oxidative stability.

Table 4 Fuel properties of *Pongamia pinnata* oil methyl esters

Properties	Unit	FAME	EN 14214	ASTM D6751
Density @ 15 °C	g/cm ³	0.883	0.86-0.90	-
Viscosity @ 40 °C	cSt	5.87	3.50-5.00	1.9-6.0
Flash point	°C	140	120 min	130 min
Acid value	mg KOH/g	0.84	0.50 max	0.80 max
Total glycerine	% wt.	0.24	0.25 max	0.24 max
Free glycerine	% wt.	0.00	0.02 max	0.02 max
Monoglyceride	% wt.	0.87	0.80 max	-
Diglyceride	% wt.	0.05	0.20 max	-
Triglyceride	% wt.	0.02	0.20 max	-

Properties of *Pongamia Pinnata* oil methyl esters

The methyl esters yield was 78.26%. The fuel properties are given in Table 4, the measured fuel properties were suitable for the standards. This means that high fuel quality methyl esters was produced from crude *Pongamia pinnata* oil that original source from the southern region of Thailand in this study.

Conclusions:

Based on the physicochemical evaluation of *Pongamia pinnata* oil and its methyl esters, *Pongamia pinnata* tends to be another promising energy plant in the future of Thailand as its oil is regarded as a potential fuel substitute. The preliminary results presented serve as a basic Knowledge regarding oil content, physical and chemical properties, composition of fatty acid, composition of tocopherols and tocotrienols as well as physicochemical characteristics of methyl esters derived from *Pongamia pinnata* oil. These may be useful for future utilization of *Pongamia pinnata* as an alternative source for biodiesel production in Thailand.

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