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Production and categorization of Biodiesel from Argemone Mexicana Seed Oil: A Comparative Study through International Standards

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ABSTRACT: The universal energy crisis and green concerns impose the development of renewable, eco-friendly and sustainable fuel alternatives. In this study, the biodiesel was formed from Argemone Mexicana seed oil through a solvent-extraction as well as mechanical press method followed by transesterification. The physicochemical properties such as viscosity, density, calorific value, and flash point were examined and compared with EN 14214 and ASTM D6751 biodiesel standards. The oil extraction yield was around 30–34% depending on the solvent used, whereas biodiesel yields ranged between 80–94% in optimized reaction conditions. The values of flash point were significantly over 120 °C, ensuring secure handling and storage. The outcomes indicate that Argemone Mexicana biodiesel satisfies most global standards, highlighting its potential like a non-edible feedstock for sustainable energy production.

KEYWORDS: Argemone mexicana, renewable energy, biodiesel, flash point, transesterification

I. INTRODUCTION

The expanding demand for energy and the exhaustion of fossil fuel reserves have intended for consideration towards renewable sources. Biodiesel, an eco-friendly and non-toxic fuel, has evolved as a promising alternate for conventional diesel. Non-edible oils are mainly eye-catching as they do not fight with food crops. Along with these, Argemone Mexicana, a strong wild plant found in numerous tropical regions, is very less explored for biodiesel production.

Earlier studies have examined biodiesel from Karanja, Jatropha, and Mahua, but Argemone Mexicana remains relatively very less studied. Inadequate research exists on its physicochemical properties and conformity with international fuel standards. This study targets to:

1. Extract oil from Argemone Mexicana seeds using solvent methods as well as mechanical press methods.
2. Convert the oil into biodiesel via transesterification.
3. Characterize the fuel properties
4. Compare them with EN14214 and ASTM D6751 standards.

1.Materials and Methods:

1.1 Oil Removal

Seeds of Argemone Mexicana were dried, ground, and subjected to oil extraction through Soxhlet apparatus as well as mechanical press method. In Soxhlet apparatus, n-hexane, ethanol and methanol as solvents were tested.

Table 1. Oil yield through Soxhlet apparatus:

Experimental Run	Solvent Used	Time of Extraction (hour)	Oil Yield (%)
1	n-Hexane	6	34.0
2	Ethanol	6	32.0
3	Methanol	6	30.0

Through mechanical press method, oil yield was achieved as 30% from Argemone Mexicana seeds.

1.2 Transesterification Process

Two steps transesterification process was applied due to high free fatty acid (FFA) contents of Argemone Mexicana oil. In first step, esterification was carried out. Afterthat transesterification was performed. The esterified oil was transesterified through methanol in the presence of KOH catalyst. The methanol-to-oil molar ratio was taken as 4:1, 6:1 and 8:1, and the reaction was carried out at around 60 °C for 60, 75 and 90 minutes with constant stirring speed. Biodiesel and glycerol were separated by settling process and then purified by washing through warm water.

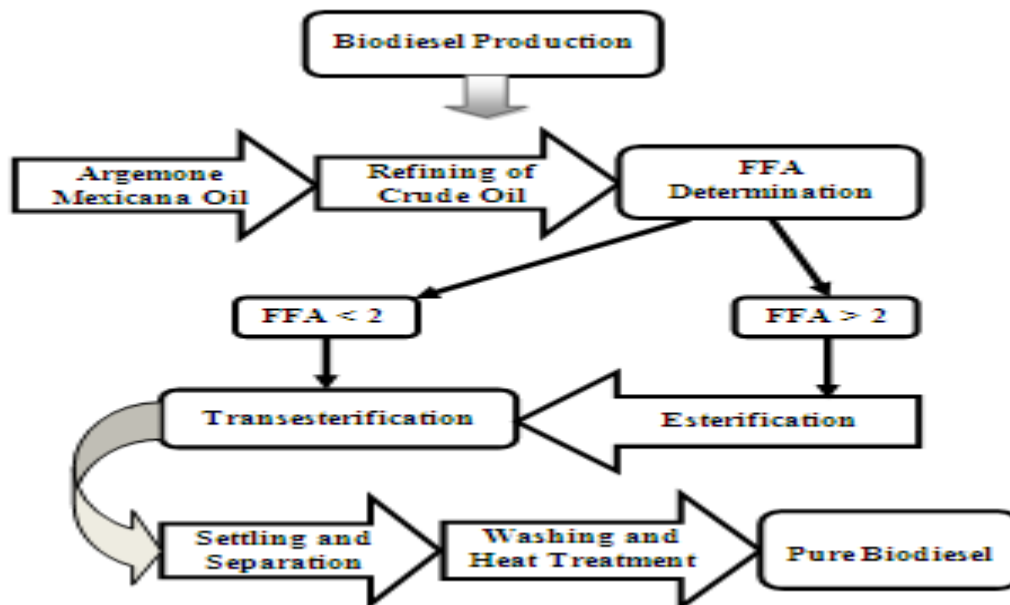


Figure 1: Activity flow chart for Biodiesel production

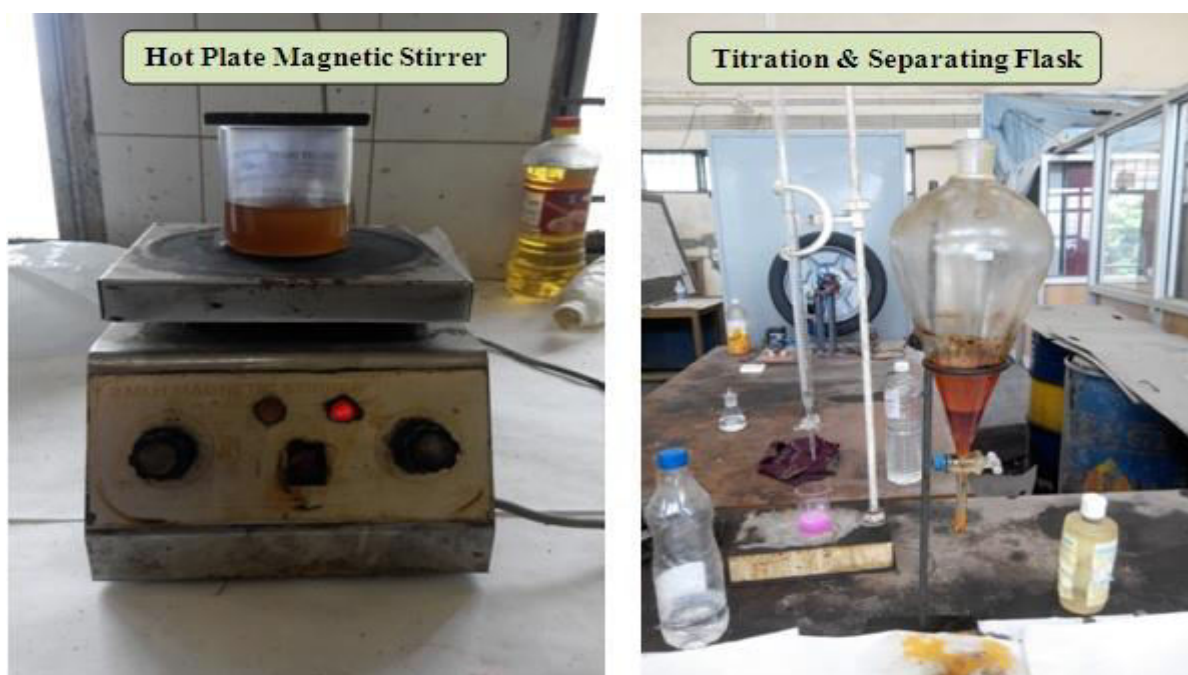


Figure 2: Biodiesel Production Setup

Fuel Property Analysis

Properties such as density, kinematic viscosity, flash point, calorific value, and cetane number were measured according to ASTM standard procedures.

Table 2. Physicochemical properties of Argemone Mexicana biodiesel compared with standard values

Properties	A M Biodiesel	ASTM Range D6751	EN 14214 Range
Density at 15 °C (g/cm ³)	0.8696	0.82 – 0.90	0.86 – 0.90
Kinematic Viscosity at 40 °C (mm ² /s)	4.8626	1.9 – 6.0	3.5 – 5.0
Flash Point (°C)	190	> 93	> 101
Calorific Value (MJ/kg)	36.5	35 – 42	37 – 42
Cetane Number	49	> 47	> 51

II. RESULTS AND DISCUSSION

The oil yield obtained with n-hexane (34.0%) was maximum compared to ethanol, methanol, or mechanical press method, confirming that non-polar solvents are more effective for seed oil

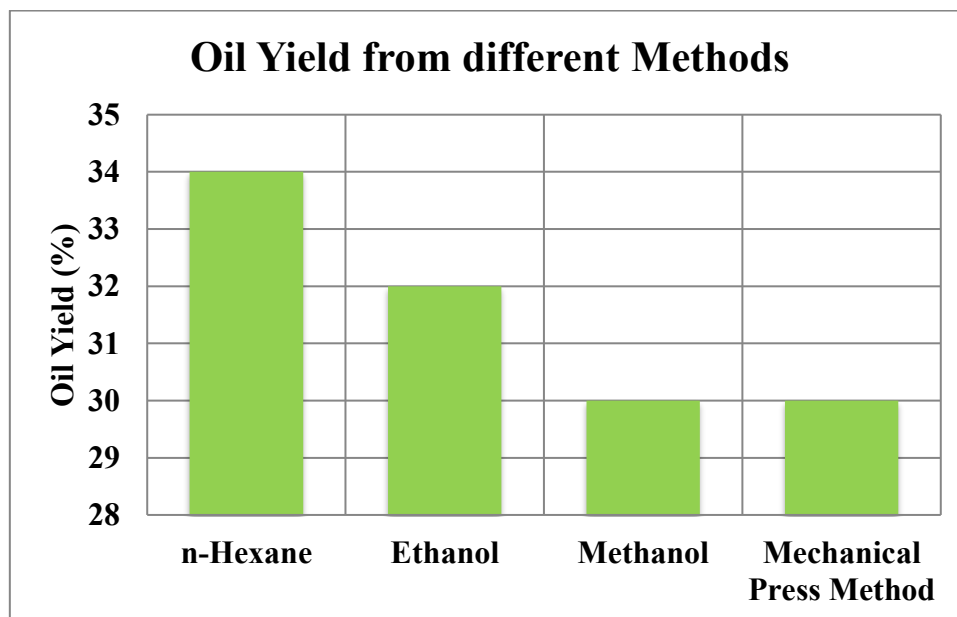


Figure 3: Oil Yield from various method

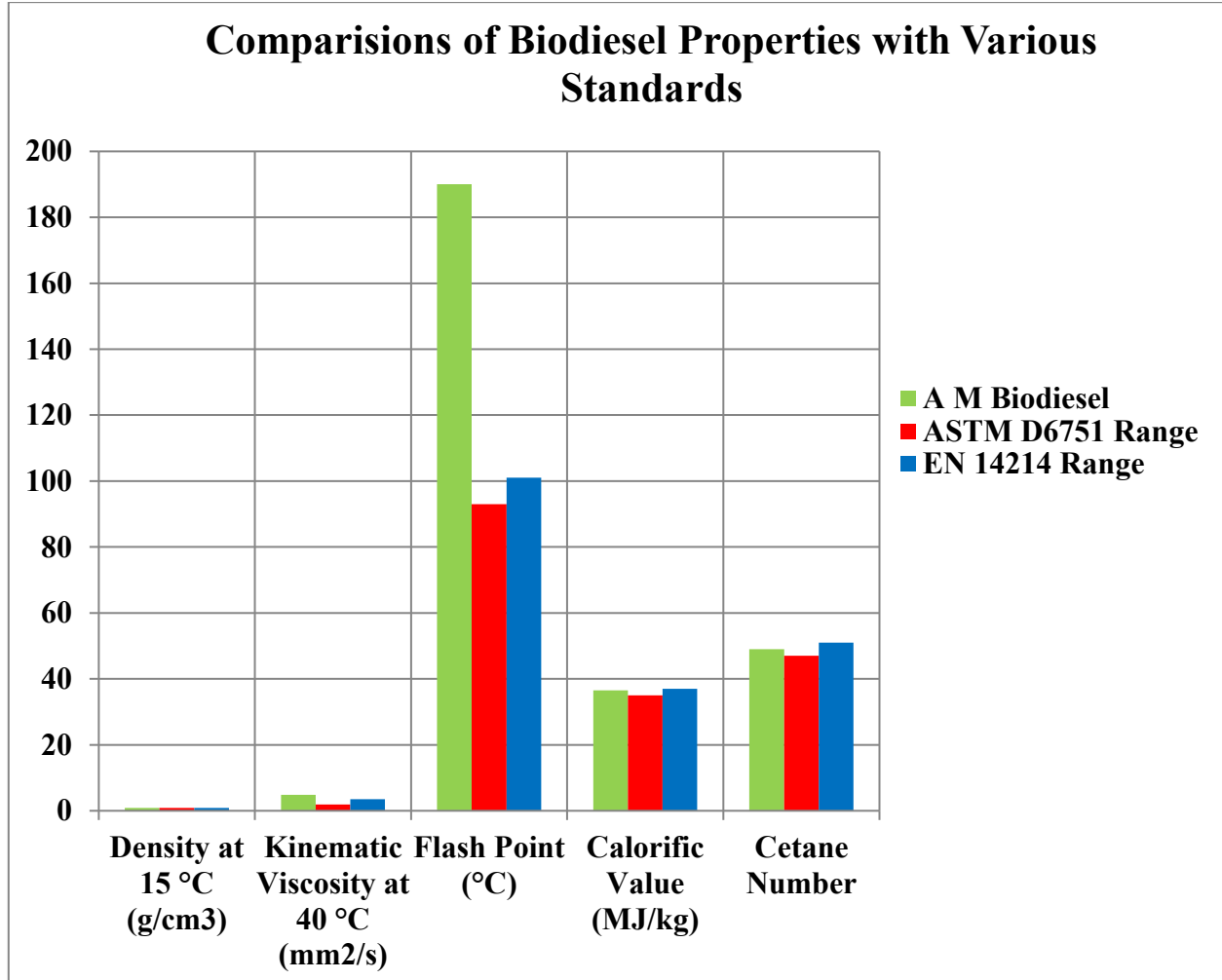


Figure 4: comparison of biodiesel properties with different standards

extraction. The transesterification process delivered biodiesel in the range of 80–94% for different set of experiment, signifying good conversion efficiency.

The fuel property investigation indicates that Argemone Mexicana biodiesel meets or exceeds the minimum values of most ASTM D6751 and EN 14214 standards. The flash point of 190 °C is appreciably higher than the least mandatory values, ensuring safety during storage and transportation. The kinematic viscosity of 4.8626 mm²/s falls within tolerable limits. The cetane number (49) suggests fine ignition quality. It falls little short as per EN 14214 ranges but well within ASTM D6751 ranges.

These outcomes highlight the possible potential of Argemone Mexicana seeds as a non-edible feedstock for biodiesel production, with properties comparable to different international standards such as ASTM D6751 and EN14214.

III. CONCLUSION

Biodiesel is one of the currently available sources of clean and renewable energy that could fulfill future energy requirements. In present research work, it is found out that:

1. Solvent (n-hexane) extraction of Argemone Mexicana seeds yielded out to 34% oil.
2. Transesterification yielded biodiesel with great conversion efficiency.

3. Physicochemical properties of biodiesel came out well within ASTM D6751 and EN 14214 standard ranges.
4. High flash point as 190 °C ensures safe handling.

Argemone Mexicana biodiesel demonstrates a promising and sustainable, non-edible feedstock for clean, green and renewable energy production.

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