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## Optimization of Transesterification Process for Production of Thumba Methyl Ester

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**ABSTRACT:** Biodiesel a promising substitute as an alternative fuel has gained significant attention due to the predicted shortness of conventional fuels and environmental concern. The utilization of liquid fuels such as biodiesel produced from oil by the transesterification process represents one of the most promising alternative options for conventional fossil fuels.

In the present study optimization of biodiesel production from thumba oil through transesterification process is carried out with excess of methanol and KOH catalyst in small batches. The effect of different parameters like molar ratio, KOH concentration, temperature, stirring speed, time of the transesterification process with respect to percentage of yields is analysed and optimized through the graphs and charts. From the extensive experimental results, it is observed that the maximum yield of thumbamethyl ester is obtained at 6:1 molar ratio, 0.75% of KOH at 65°C temperature with 250 R.P.M and 70 Min. of reaction time.

**KEYWORDS:** Thumba oil, Transesterification, Process optimization, % yield.

### I. INTRODUCTION

All countries are at present heavily dependent on petroleum fuels for transportation and agricultural machinery. The fact that a few nations together produce the mass of petroleum has led to high price fluctuation and uncertainties in supply for the consuming nations. This in turn has led them to look for alternative fuels that they themselves can produce. An alternative fuel should be by far available, environmentally friendly and techno-economically competitive. The esters of vegetable oils or animal fats appear to be most capable alternative. Today, methyl or ethyl esters of fatty acid are used as substitutes for diesel fuel under the name of biodiesel [1]. Biodiesel fuel has many advantages over diesel fuel like produce less smoke and particles, have a higher cetane number, produce low carbon monoxide (CO) and hydrocarbons (HC) emission, they are renewable, ecological and non-toxic. Biodiesel obtained from vegetable oil can be used as conventional diesel in diesel engines because its properties are very close to petroleum diesel [2-3].

One of the most capable processes to convert vegetable oil into methyl ester is the transesterification, in which alcohol reacts with triglycerides of fatty acids (vegetable oil) in the presence of a catalyst [4-6]. The main commodity sources of biodiesel in India are non edible oils obtained from plant species such as *Jatropha*, *Pongamia Pinnata*, *Thumba*, *Neem*, *Jojoba*, *Castor* etc [7-8].

In the present study optimization of biodiesel production from thumba oil through transesterification process is carried out by considering parameters like molar ratio catalyst concentration, reaction temperature, stirring speed and reaction time.

### II FUEL SELECTION AND EXPERIMENTAL METHODOLOGY

#### 2.1 Selection of Biodiesels

In the present investigation non-edible vegetable oil, thumba oil has been chosen to explore its possibility and potentiality as diesel engine fuel. In India it mainly grows in almost all parts of Rajasthan and Gujarat. Figure 1 shows the thumba fruits. The important chemical and physical properties of thumba oil is determined and compared with diesel. Some of the measured properties of pure thumba oil are presented shown in Table.1.

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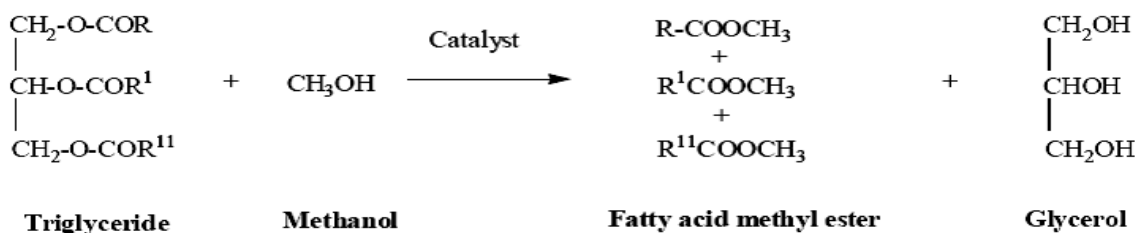
Fig. 1.Thumba Fruits

Table 1. Some Important Fuel Properties of Thumba Oil

Properties	Diesel	Thumba Oil
Specific Gravity at 20° C	0.835	0.905
Viscosity, CSt at 40° C	2.75	31.52
Calorific Value,MJ/Kg	42.25	39.78
Flash Point ° C	66	201
Pour point ° C	-20	-5
Free Fatty Acid, %	-	>1
Cetane Number	47	45

## 2.2 Methodology

Transesterification also called alcoholysis, is the displacement of alcohol from an ester by another alcohol in a process similar to hydrolysis. This process has been widely used to reduce the viscosity of triglycerides. The transesterification reaction is represented by the general equations

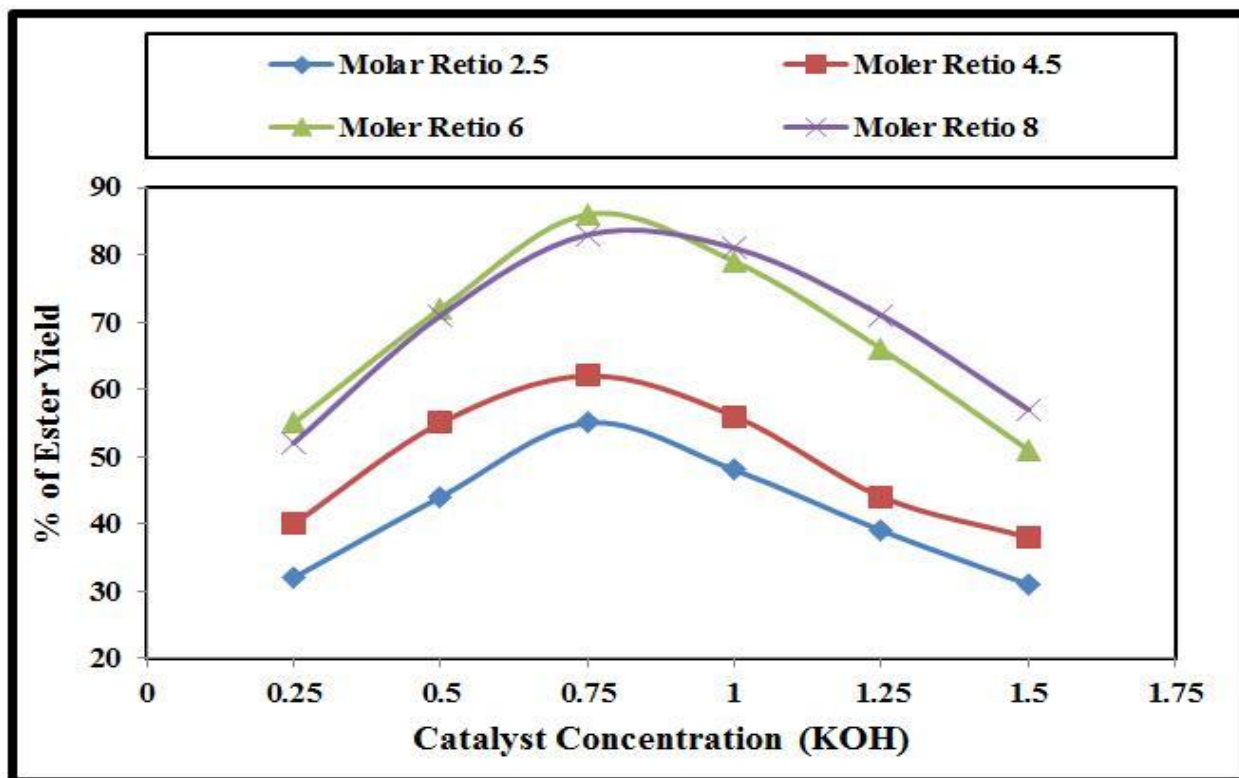


**III RESULTS AND DISCUSSION**

The extensive experimental investigations were conducted for transesterification process of thumba oil to get thumba methyl ester and variation parameters like molar ratio KOH concentration, temperature variation, stirrer speed, with respect to percentage yield of Biodiesel is investigated and optimized through graph and charts

**3.1 Effect of Molar Ratio & Catalyst Concentration**

In the graph 1 the effect of concentration of catalyst has been studied with respect to the percentage of yield for different molar ratios, the range of molar ratio in the present investigation is taking from 2.5 to 8 and the effect of catalyst in taken from 0.25% to 1.5%.Molar ratio of alcohol to vegetable oil is one of the most important parameters affecting the yield of ester. The graph shows that all molar ratios have a slightly low yield at low catalyst concentration. The trend of graph shows that yield in increase for lower concentration of KOH up to 0.75% KOH and then it is declined after the concentration KOH for all molar ratios.Biodiesel yield compared to all molar ratios, 6 molar ratio, which gives a slightly higher yield at all catalyst concentration. The yield is found maximum at around 0.75% of catalysts KOH for the 6 molar ratio. The molar ratio 6 has been found optimum which is given yield 86% at 0.75% KOH concentration, although molar ratio 8 has also given comparable yield compared to molar ratio 6 but the excess amount of alcohol add the additional cost of the transesterification process so molar ratio 6 has considered as an optimum molar ratio at 0.75% of KOH. The molar ratio 2.5 and 4.5 gives the lower ester yield fact that the excess alcohol is not available for thetransesterificationreaction, which is the prime requirement of the reaction. High concentration of KOH reduces the yield because of high soap formation and also leads to undesirable extra processing cost because it is necessary to remove it from the reaction products at the end.



Graph 1. Effect of KOH Concentration with Respect To Percentage of Yield of Thumba Methyl Ester for Different Molar Ratios

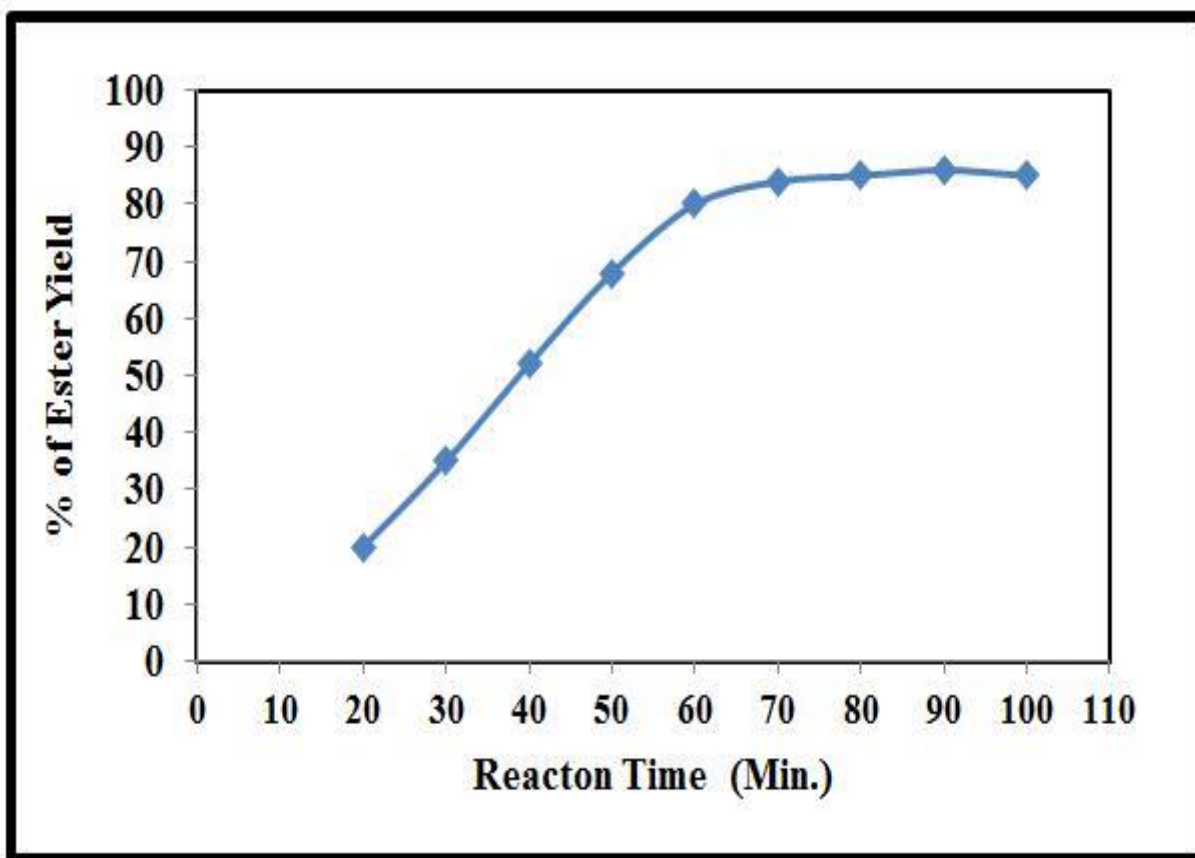
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### 3.2. Effect of Reaction Time

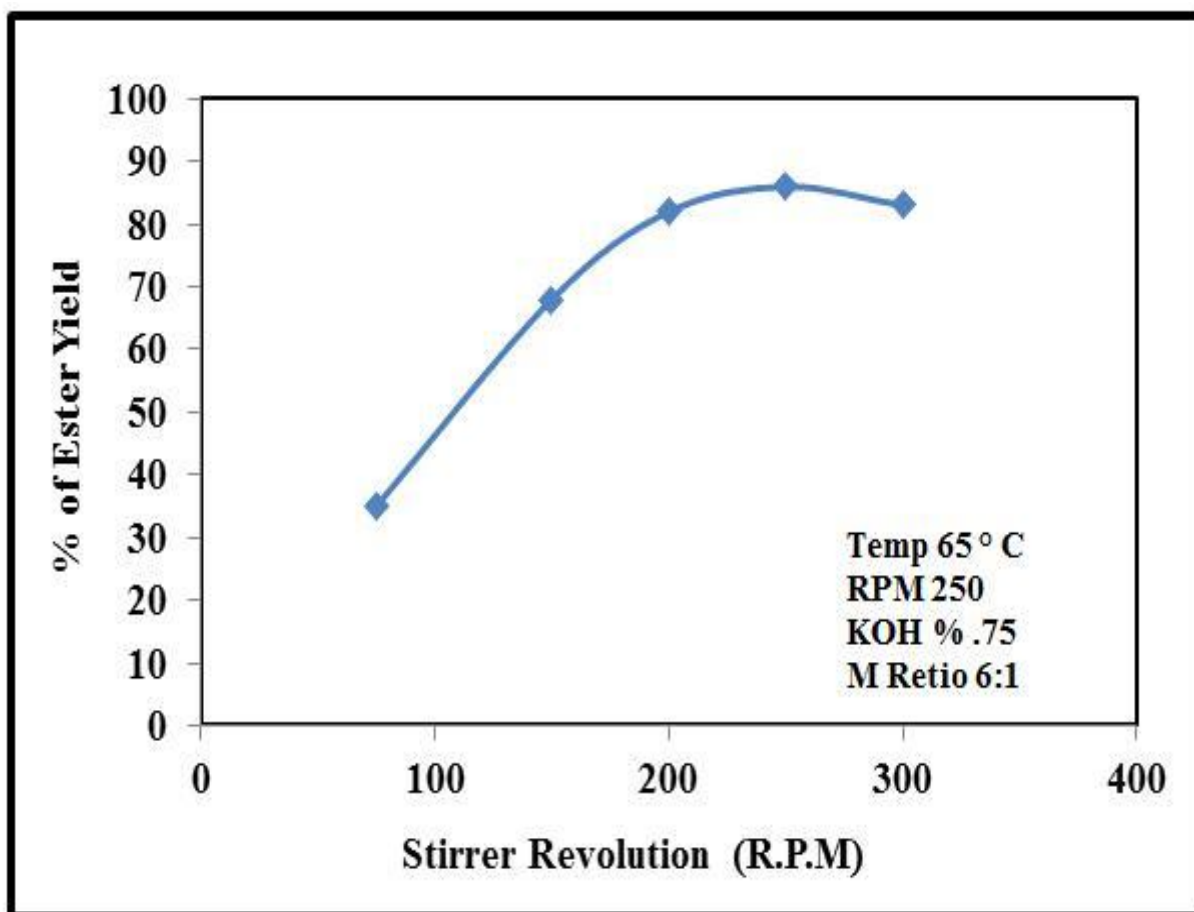
The effect of reaction time for transesterification process with percentage of yield of biodiesel produced is also evaluated in the present study. The reaction time is taken from 20 to 100 Min., with the interval of 10 min., keeping the optimum molar ratio 6:1, catalyst concentration of 0.75% with the previously found optimum reaction temperature 65°C. The transesterification reaction proceeds quickly and around 31 % of ester is converted in 30 min. After one hour around 78 % of ester is produced, after 70 min around 86% of ester is found and after that slightly reduced percentage of easter is observed, this is happening because the reverse reaction is also started, so we can see from the graph 2 that the constant value of ester produced is observed after 70 min due to forward and reversed reactions. So it is concluded that around 70 min reaction time is optimum and we got around 86% of ester production and after that, ester production is almost constant up to 90 min. of reaction time.



Graph 2. Effect of Reaction Time with Respect to Percentage of Yield of ThumbaMethyl Ester

### 3.3 Effect of Stirrer Rotation

In this study different stir R.P.M. are undertake to find the effect of stirrer for transesterification process and to get optimum R.P.M. for biodiesel production. Graph 3 shows the effect of stir revolution per minutes with respect to percentage of yield at all ready found optimum condition of molar ratio, KOH concentration and reaction temperature. It is observed form the graph that with increase of R.P.M. of the stirrer increase the percentage yield of ester up to 250 R.P.M. and then it decreases slightly at 300 R.P.M. Because thevery smooth vortex is produced at 250 R.P.M.. It is seen that the stirrer is not proper at higher R.P.M. The turbulence is higher which reduce the ester production.



Graph 3. Effect of Stirrer with Respect to Percentage of Yield of Thumba Methyl Ester

### 3.4 Effect of Reaction Temperature

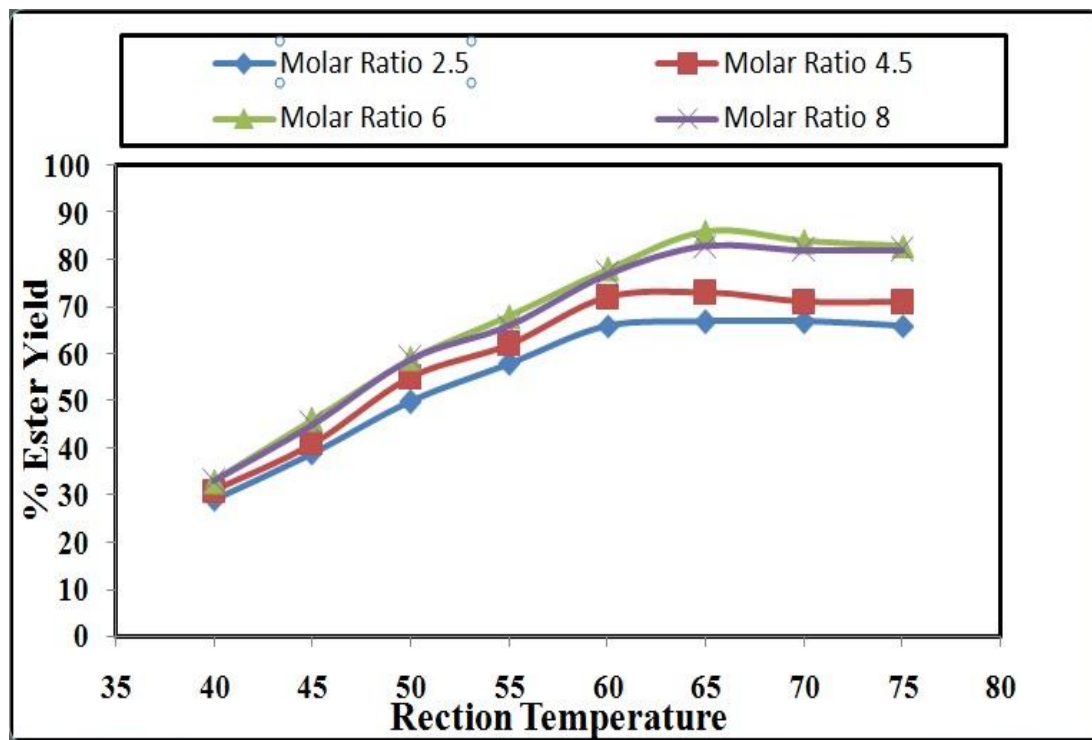
In the present study the effect of transesterification reaction temperature with respect to percentage yields of biodiesel production for different molar ratios, from 2.5 to 8 is studied and optimized. It is seen from the graph 4 that with increase in the temperature, the percentage of yields is increasing. This trend is followed for all molar ratios due to reaction rate increase with increase in temperature. The maximum temperature of the reaction is limited due to boiling point of alcohol. The temperature higher than 65°C evaporates the alcohol from the reaction and reduces the rate of reaction due to insufficient alcohol percent in the reaction. It is clearly seen from graph that after 65°C, the percentage yields of ester are reducing. It is also seen from the graph that molar ratio 6 has a higher percentage of yields followed by 8:1 molar ratio which is very close to molar ratio 6. The molar ratio 2.5 and 4.5 have a lower percentage of yields at all temperatures because the transesterification reaction required excess of alcohol and this excess alcohol. In 8 molar ratio the alcohol present is more compared to 6 molar ratio for the almost same results hence, increasing the cost of reaction. So from the above discussion, we can safely consider molar ratio 6 as optimum at temperature 65 °C.



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Graph 4. Effect of Reaction Temperature With Respect To Percentage of Yield of Thumba Methyl Ester For different Molar Ratios

### IV CONCLUSION

In the present study thumba oil is chosen to produce biodiesel because thumba is a one of the best and most suitable feed stock for biodiesel production in the arid regions of Rajasthan Gujarat and Panjab. From the extensive experimental investigation it is observed that methanol with molar ratio 6:1 and 0.75% concentration of catalyst by weight gives optimum yield of thumba methyl ester at 65°C temperature with 250 RPM of stirring speed at around 70 min reaction time.

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