

Fig. 3 — GC-MS spectrum of extracted *Annona squamosa* seed oilFig. 4 — Arrhenius plot of $\log(K)$ versus $1/T$ for determination of activation energy**Kinetics study and determination of activation energy**

The kinetics for oil extraction were studied under various time (5, 10, 15, 20 min) and intervals of temperature (30, 40, 50, 60°C). The graph drawn between $\log(Y)$ vs $\log(dY/dt)$ at different time and temperature was noted. The biooil extraction process from *Annona squamosa* seed found to be fitted suitably under first-order reaction kinetics model. The process of biooil extraction was subjected to different extraction time intervals and temperature to study the kinetics. The minimum energy required for the biooil extraction process was determined by the graph plotted between $\log(K)$ and $1/T$ shown in Fig. 4. The activation energy for the biooil extraction process was determined and found to be $E_a = 66.56 \text{ kJ/mol}^{22}$.

Physicochemical properties of extracted *Annona squamosa* seed oil

The physicochemical properties of the extracted *Annona squamosa* seed oil was analyzed and thus the

Table 1 — Physicochemical properties of extracted *Annona squamosa* seed oil

S. No.	Parameters	Results
1	FFA	9.02 NaOH in mL/ g of oil
2	Density	0.928 g/cc
3	Kinematic viscosity @ 40°C	6.42 cSt
4	Cloud point	6°C
5	Pour point	-8°C
6	Moisture content	1.00 %
7	Calorific value	6315.808 Cal/g

results were shown in Table 1. The free fatty acid of *Annona squamosa* seed oil was 9.02 NaOH in mL/ g of oil²³. The oil density is 0.928 g/cc and 6.42 cSt is the kinematic viscosity which was analyzed at 40°C for the sample. Cloud and pour points are 6 and -8°C respectively. The moisture content is 1.00%. Higher moisture content affects the process of transesterification and decreases yield of the methyl ester. The determined calorific value of

Annona squamosa seed oil was found to be 6315.808 Cal/g²².

Conclusion

The homogeneous solvent based ultrasonic assisted solvent extraction method has been used of extraction of biooil from the *Annona squamosa* seeds. The extraction time of 20 min, temperature of 50 °C and hexane to biomass ratio of 3:1 v/w are found as optimum for maximum biooil yield of 23% (w/w) from *Annona squamosa* seeds. The kinetics of the ultrasonic-assisted biooil extraction process is found to fit to first order reaction kinetics. The estimated activation energy of the extraction process is found to be $E_a = 66.56$ KJ/mol. The peaks obtained using FT-IR confirm the presence of functional groups and the types of vibrations were noted. The GC-MS results confirm the presence of oleic acid which is the desired fatty acid in the extracted biooil.

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