

## Supplementary material

**Response surface optimization and Artificial neural network modeling of biodiesel production from crude Mahua (*Madhuca indica*) oil under supercritical ethanol condition using CO<sub>2</sub> as co-solvent**

**Antaram N. Sarve\*, Mahesh N. Varma, Shriram S. Sonawane**

Department of Chemical Engineering, Visvesvaraya National Institute of Technology (VNIT),  
South Ambazari Road, Nagpur (M.H.) 440010, India

**\* Corresponding author:**

**A. N. Sarve**

Department of Chemical Engineering, Visvesvaraya National Institute of Technology (VNIT),  
South Ambazari Road, Nagpur (M.H.) 440010, India

E-mail address: anant4u87@gmail.com

Phone No: 07122801646

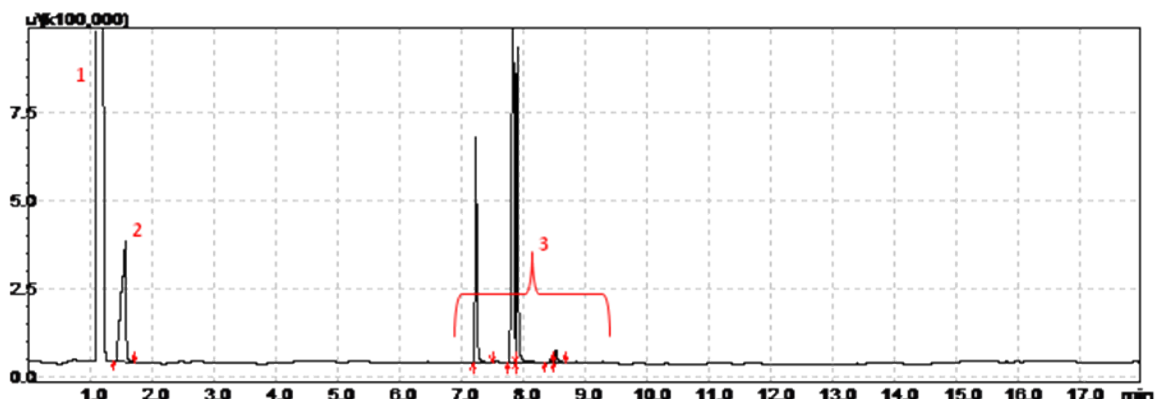
**Fig. S1.** Experimental setup

### 1. GC Analysis:

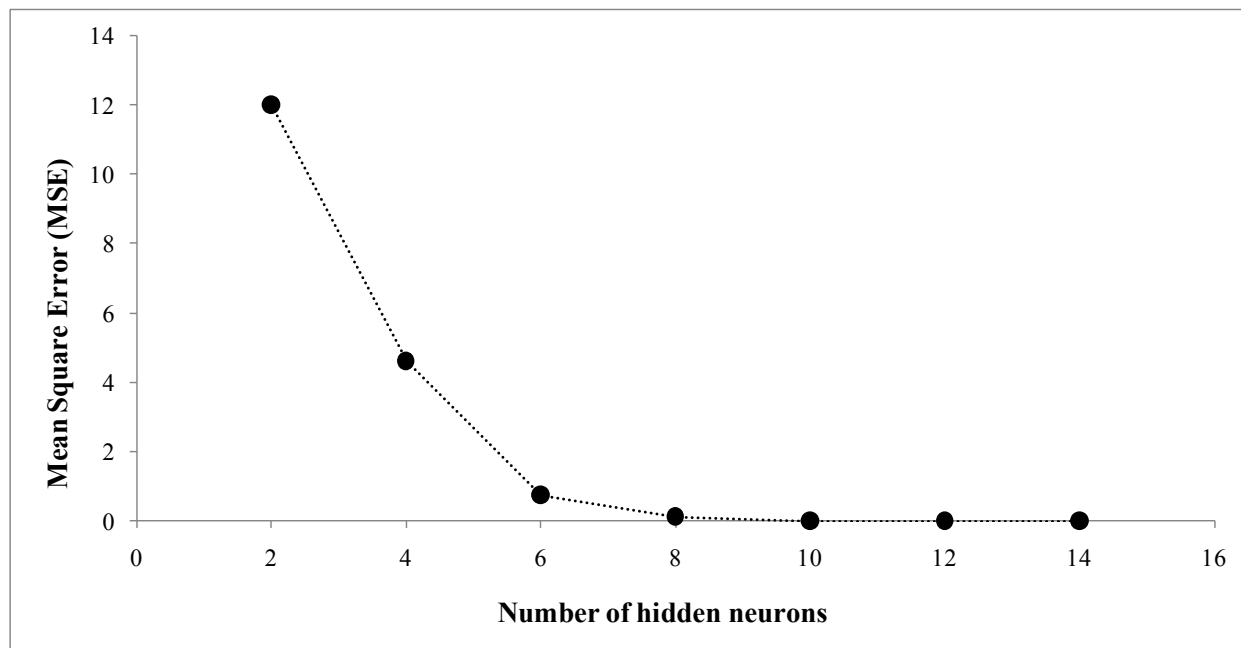
The FAEE content (mass concentration) in the product was measured by the GC analysis according to the EN 14103 test method. In this test method the methyl heptadecanoate and n-heptane were replaced with hexanoic acid and n-hexane internal standard and solvent, respectively. To measure the biodiesel content in the final product, a standard solution was prepared as 10 mg ml<sup>-1</sup> hexanoic acid with n-hexane solution at first. Then 250 mg of sample was added to 5ml of standard solution and the mixture was injected to GC column. The FAEE content and % conversion were determined by using following equation:

$$Y_{ester} (\%) = \frac{\sum A - A_s}{A_s} \times \frac{C_s V_s}{m} \times 100$$

where  $\sum A$  is the summation of GC peak areas of methyl esters (C16:0-C18:2),  $A_s$  is the GC peak area of hexanoic acid (internal STD),  $C_s$  is the concentration of STD solution (10 mg ml<sup>-1</sup>),  $V_s$  is the volume of STD solution (5 ml), and  $m$  is the amount of sample (250 mg).



**Fig. S2.** The GC chromatogram of biodiesel from Mahua oil 1) hexane 2) hexanoic acid 3) fatty acid ethyl esters (FAEE) of Mahua oil



**Fig. S3.** Effect of number of neurons in hidden layer on the Mean Square Error

**Table S1.** Fatty acid composition of Mahua (*Madhuca indica*) oil [5]

<b>Fatty Acid Composition</b>	<b>Structure</b>	<b>Composition in %</b>
Palmatic	16:0	16-28.2
Stearic	18:0	20-25.1
Oleic	18:1	41-51
Linoleic	18:2	8.9-13.7
Arachidic	20:0	0-3.3

**Table S2.** Process variables and their levels used in CCD

<b>variables</b>	<b>Symbol coded</b>	<b>Range and levels</b>				
		<b>-2</b>	<b>-1</b>	<b>0</b>	<b>1</b>	<b>2</b>
Temperature ( °C )	<i>A</i>	250	275	300	325	350
Ethanol/oil molar ratio (v/v)	<i>B</i>	15:1	20:1	25:1	30:1	35:1
Reaction time (min)	<i>C</i>	10	20	30	40	50
Initial CO <sub>2</sub> pressure (bar)	<i>D</i>	10	20	30	40	50