

Table 1 Experimental matrix and results obtained from the experimental design 2² used to optimize the independent variables light intensity (X) and concentration of NaNO₃ (Y) in the culture medium.

Assay	Variable				Biomass productivity (mg/L/day)				Lipid content (%)				Lipid productivity (mg/L/day)			
					CACIAM ²				CACIAM				CACIAM			
	Coded		Real ¹		05	08	18	25	05	08	18	25	05	08	18	25
	X	Y	X	Y												
1	-	-	15	1	26.8	12.1	23.2	24.2	15.3	12.4	20.6	33.1	4.1	3.8	4.8	3.4
2	-	+	15	2	37.4	15.3	33.2	42.1	18.9	31.7	32.9	14.4	7.1	2.3	10.9	24.6
3	+	-	100	1	39.5	16.3	34.7	39.0	25.6	15.0	37.9	58.3	10.1	7.2	13.2	11.1
4	+	+	100	2	48.4	18.4	45.8	53.7	17.9	44.0	20.7	28.4	8.7	3.3	9.5	7.4
5	0	0	57.5	1.5	34.6	9.5	34.2	30.5	18.1	18.1	13.7	7.8	6.3	1.7	4.7	2.4
6	0	0	57.5	1.5	36.1	10.2	34.0	29.7	18.7	18.9	14.9	8.5	6.7	1.9	5.1	2.5
7	0	0	57.5	1.5	35.8	9.2	34.6	31.6	17.6	17.3	12.4	7.0	6.3	1.6	4.3	2.2

¹ X= Luminous intensity ($\mu\text{mol}/\text{m}^2\text{s}$) and Y= NaNO₃ concentration (g/L)

² *Synechocystis* sp. CACIAM05, *Microcystis aeruginosa* CACIAM08, *Leptolyngbya* sp. CACIAM18 and *Limnothrix redekei* CACIAM25

Table 21 Lipidic Fatty acid profile (%) extracted from cyanobacteria strains

Strains	Fatty acid										SFA	MUFA	PUFA
	C12:0	C14:0	C16:0	C16:1	C17:0	C18:0	C18:1	C18:2	C18:3	C20:0			
<i>Synechocystis</i> sp. CACIAM05 NaNO ₃ + / Light +	9.16	7.08	54.96	-	-	9.62	-	-	-	-	80.82	0.00	0.00
<i>Synechocystis</i> sp. CACIAM05 NaNO ₃ + / Light -	-	-	29.90	2.13	2.13	-	42.65	-	-	-	32.03	44.78	0.00
<i>Synechocystis</i> sp. CACIAM05 NaNO ₃ - / Light +	-	-	37.65	2.25	2.27	-	28.15	-	-	-	39.92	30.41	0.00
<i>Synechocystis</i> sp. CACIAM05 NaNO ₃ - / Light -	-	-	37.77	2.01	2.06	-	20.55	-	-	-	39.83	22.56	0.00
<i>Synechocystis</i> sp. CACIAM05 NaNO ₃ 0 / Light 0	-	-	60.52	-	-	2.62	-	14.65	2.96	-	63.14	0.00	17.61
<i>M. aeruginosa</i> CACIAM08 NaNO ₃ + / Light +	-	-	29.97	-	-	15.32	49.50	-	-	1.33	46.62	49.50	0.00
<i>M. aeruginosa</i> CACIAM08 NaNO ₃ + / Light -	-	-	25.71	-	28.36	-	43.90	-	-	-	54.07	43.90	0.00
<i>M. aeruginosa</i> CACIAM08 NaNO ₃ - / Light +	-	-	-	-	23.77	5.69	5.81	-	-	-	29.47	5.81	0.00
<i>M. aeruginosa</i> CACIAM08 NaNO ₃ - / Light -	-	1.62	33.14	-	11.25	11.20	15.42	-	-	1.39	58.61	15.42	0.00
<i>M. aeruginosa</i> CACIAM08 NaNO ₃ 0 / Light 0	-	-	31.18	-	20.67	3.95	29.87	-	-	-	55.80	29.87	0.00
<i>Leptolyngbya</i> sp. CACIAM18 NaNO ₃ + / Light +	-	9.92	32.99	34.13	-	-	4.59	-	-	-	42.92	38.72	0.00
<i>Leptolyngbya</i> sp. CACIAM18 NaNO ₃ + / Light -	-	9.91	25.22	52.55	-	-	-	-	-	-	35.13	52.55	0.00
<i>Leptolyngbya</i> sp. CACIAM18 NaNO ₃ - / Light +	-	18.58	29.66	23.79	-	-	-	-	-	-	48.23	23.79	0.00
<i>Leptolyngbya</i> sp. CACIAM18 NaNO ₃ - / Light -	-	14.91	32.74	42.96	-	2.42	-	-	-	-	50.06	42.957	0.00
<i>Leptolyngbya</i> sp. CACIAM18 NaNO ₃ 0 / Light 0	-	18.10	29.86	25.51	-	-	7.79	-	-	-	47.97	33.30	0.00
<i>Limnothrix redekei</i> CACIAM25 NaNO ₃ + / Light +	-	3.59	22.12	5.11	20.54	9.44	33.33	-	-	1.15	56.83	38.44	0.00
<i>Limnothrix redekei</i> CACIAM25 NaNO ₃ + / Light -	-	-	39.83	-	12.72	8.97	38.49	-	-	-	61.51	38.49	0.00
<i>Limnothrix redekei</i> CACIAM25 NaNO ₃ - / Light +	-	10.62	43.29	20.93	-	3.47	-	13.05	-	-	57.38	20.93	13.05
<i>Limnothrix redekei</i> CACIAM25 NaNO ₃ - / Light -	-	1.62	33.14	-	11.25	11.20	15.42	-	-	1.39	48.15	33.08	0.00
<i>Limnothrix redekei</i> CACIAM25 NaNO ₃ 0 / Light 0	-	-	23.39	3.43	29.45	-	32.88	-	-	-	52.84	36.31	0.00

+ = high level, - = low level, 0 = central level for the variables: NaNO₃ concentration and light intensity

SFA: saturated fatty acids, MUFA: monounsaturated fatty acids, PUFA: polyunsaturated fatty acids

Table 3 Empirical parameters of biodiesel quality based on the fatty acid profile of cyanobacterial strains

Strains	DU	SV (mg/g)	IV	CN	LCSF	CFPP (°C)	CP (°C)	PP (°C)	APE	BAPE	HHV	ν (mm ² /s)	P (g/cm ³)
¹ CACIAM05 NaNO ₃ + / Light +	0.0	181.9	0.0	76.3	10.3	15.9	23.9	19.1	0.0	0.0	31.5	2.8	0.7
CACIAM05 NaNO ₃ + / Light -	44.8	159.0	40.5	71.5	3.0	-7.1	10.7	4.8	42.7	0.0	30.3	2.9	0.7
CACIAM05 NaNO ₃ - / Light +	30.4	147.7	27.6	77.1	3.8	-4.7	14.8	9.3	28.2	0.0	27.7	2.6	0.6
CACIAM05 NaNO ₃ - / Light -	22.6	131.9	20.5	83.1	3.8	-4.6	14.9	9.3	20.6	0.0	24.5	2.3	0.5
CACIAM05 NaNO ₃ 0 / Light 0	35.2	172.5	34.6	70.1	7.4	6.7	26.8	22.3	35.2	20.6	31.7	2.9	0.7
² CACIAM08 NaNO ₃ + / Light +	49.5	196.2	44.5	64.1	12.0	21.2	10.8	4.9	49.5	2.7	38.0	3.9	0.8
CACIAM08 NaNO ₃ + / Light -	43.9	201.9	39.5	64.5	2.6	-8.4	8.5	2.4	43.9	0.0	38.7	4.0	0.9
CACIAM08 NaNO ₃ - / Light +	5.8	72.0	5.2	121.0	2.9	-7.5	-5.0	-12.2	5.8	0.0	14.0	1.7	0.3
CACIAM08 NaNO ₃ - / Light -	15.4	154.9	13.9	78.4	10.3	15.9	12.4	6.7	15.4	2.8	29.2	2.9	0.6
CACIAM08 NaNO ₃ 0 / Light 0	29.9	177.9	26.9	70.9	5.1	-0.5	11.4	5.6	29.9	0.0	33.8	3.3	0.7
³ CACIAM18 NaNO ₃ + / Light +	38.7	180.6	38.2	67.9	3.3	-6.1	12.4	6.6	4.6	0.0	31.8	2.7	0.7
CACIAM18 NaNO ₃ + / Light -	52.6	195.0	52.5	62.5	2.5	-8.6	8.3	2.2	0.0	0.0	34.1	2.8	0.8
CACIAM18 NaNO ₃ - / Light +	23.8	162.7	23.8	74.5	3.0	-7.2	10.6	4.7	0.0	0.0	28.0	2.4	0.6
CACIAM18 NaNO ₃ - / Light -	43.0	207.4	42.9	63.0	4.5	-2.4	12.2	6.5	0.0	0.0	36.2	3.1	0.8
CACIAM18 NaNO ₃ 0 / Light 0	33.3	181.2	32.5	69.1	3.0	-7.1	10.7	4.8	7.8	0.0	31.7	2.7	0.7
⁴ CACIAM25 NaNO ₃ + / Light +	38.4	197.7	35.1	66.0	8.1	8.9	6.6	0.4	33.3	2.3	37.6	3.8	0.8
CACIAM25 NaNO ₃ + / Light -	38.5	207.3	34.6	64.9	8.5	10.1	16.0	10.5	38.5	0.0	39.5	4.1	0.9
CACIAM25 NaNO ₃ - / Light +	47.0	199.5	44.5	63.6	6.1	2.6	17.8	12.5	26.1	13.1	35.7	3.1	0.8
CACIAM25 NaNO ₃ - / Light -	33.1	167.7	30.1	72.1	6.3	3.4	6.8	0.5	30.0	0.0	32.1	3.2	0.7
CACIAM25 NaNO ₃ 0 / Light 0	36.3	184.8	33.0	68.4	2.3	-9.1	7.3	1.1	32.9	0.0	35.2	3.5	0.8

¹*Synechocystis* sp. CACIAM05, ²*Microcystis aeruginosa* CACIAM08, ³*Leptolyngbya* sp. CACIAM18, ⁴*Limnithrix redekei* CACIAM25

Table 5 Strain sources used in this study.

Strain	Local
<i>Microcystis aeruginosa</i> CACIAM03	Hydroelectric plant of Tucuruí reservoir
<i>Synechocystis</i> sp. CACIAM05	Bologna Lake
<i>Lyngbya</i> sp. CACIAM07	Hydroelectric plant of Tucuruí reservoir
<i>Microcystis aeruginosa</i> CACIAM08	Hydroelectric plant of Tucuruí reservoir
<i>Synechococcus</i> sp. CACIAM66	Hydroelectric plant of Tucuruí reservoir
<i>Leptolyngbya</i> sp. CACIAM18	Bologna Lake

<i>Limnothrix redekei</i> CACIAM25	Hydroelectric plant of Tucuruí reservoir
<i>Planktothrix pseudoagardhii</i> CACIAM27	Hydroelectric plant of Tucuruí reservoir

Table 6 Real and coded levels for the variables: luminous intensity and nitrogen levels (NaNO₃) in the cultivation of cyanobacteria

Variable		Level		
Independent variables	Symbol	-1	0	1
Light intensity ($\mu\text{mol}/\text{m}^2\text{s}$)	X	15	57.5	100
NaNO ₃ (g/L)	Y	1	1.5	2.0

