Sustainable fermentable sugar production using glass fiber supported gallium-molybdenum photocatalyst towards bioethanol: LCA analysis

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Table S1. Analysis of Variance

Source	DF	Adj. SS	Adj. MS	F-Value	P-Value
Regression	4	1108.72	277.179	4.84	0.078
(R_T) (°C)	1	522.67	522.667	9.13	0.039
(R_t) (min)	1	3.29	3.286	0.06	0.822
(C_c) (wt. %)	1	512.45	512.450	8.95	0.040
(P_L) (wt. %)	1	70.32	70.315	1.23	0.330
Error	4	228.94	57.235		
Total	8	1337.66			

S1. Pretreatment of corncob

The procured corncob was carefully cleaned with hot water and dried. It was then grounded to produce uniformly fine particles (-250 ~ +300 mesh screen). To separate lignin, 40g corn cob was heated for 3 hours at 80 °C with a 100 ml acetic acid plus H_2O_2 mix solution (9: 1) solution. The resultant mixture was then filtered and the residue was collected. The residue was then washed with hot water and ultra-sonicated for 30mins. It was then filtered and the residue was dried overnight in a hot air oven at 60°C. This DCC (delignified corncob) was then used for experimental runs.

S2. Compositional analysis of corncob and DCC

The composition of the corncob and DCC was analyzed for cellulose, hemicellulose and lignin content. The lignin content was measured by measuring the weight difference of the corncob before and after the treatment with peroxide acetic acid. The cellulose and hemicellulose content were calculated by completely hydrolyzing the corncob with conc. H_2SO_4 and measuring the glucose (for cellulose) and xylose (for hemicellulose) content in the hydrolysate by using HPLC analysis. The method was repeated for the compositional analysis of DCC. The compositional analysis of corncob and DCC are presented in Table S2. Furthermore, the DCC's carbon, hydrogen, nitrogen and sulfur content has been analyzed using CHNS analyzer, and the results are given in Table S3.

Table S2. Composition of corncob and DCC

Biomass	Cellulose (wt. %)	Hemicellulose (wt. %)	Lignin (wt. %)
Corncob	33.54	32.16	17.3
DCC	75.14	22.65	2.1

Table S3. CHNS analysis of DCC

Carbon (%)	Hydrogen (%)	Nitrogen (%)	Sulphur (%)
43.30	5.686	0.39	0.219

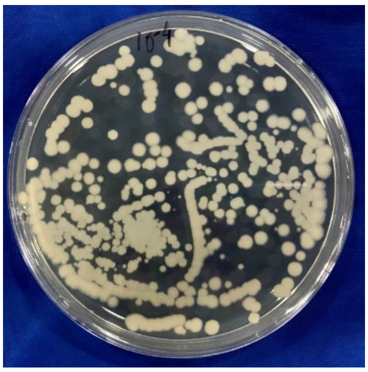

Fig. 1S: Colonies of *P. stipitis* NCIM 3499

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Table S4. LCI data for preparation of 1 kg powdered W-PCB powder

Category	Flow	Value	Unit	Comments
Energy Input	Electricity	0.50	kWh	
Material Input	W-PCB	1.0097	Kg	
	NaOH	0.80		
Emissions to air	Waste Heat	1.80	MJ	
	Particulates <10µm	0.0097	Kg	
Transports	W-PCB	0.0063	Kg*Km	Transport by lorry, capacity: 16 metric ton, EURO IV / BS IV (assuming all materials came from 100 km distance)
	NaOH	0.005		
	Total	**0.0113**		
Output	Powdered W-PCB	1	kg	

Table S5. LCI data for treatment of 1 kg of powdered W-PCB

Category	Flow	Value	Unit	Comments
Energy Input	Energy consumed		kWh	
	For magnetic stirring	0.05		
	Peroxyacetic acid treatment	0.2		
	During ultrasonication	0.1875		
	For Oven drying	0.8		
	Total	**1.2375**		
Material Input	Powdered W-PCB	1	kg	
	DMF	0.188		
	Acetic Acid	0.12		
	H_2O_2	0.066		
	DI Water	3.25		
Emissions to air	Waste Heat	4.455	MJ	Assuming 5% water vapour emitted to air
	Water Vapour	0.184	Kg	
Transports	DMF	0.0012	Kg*Km	
	Acetic Acid	0.00075		
	H_2O_2	0.00041		
	DI Water	0.020		
	Total	**0.0224**		
Waste of Materials	Waste Water	0.425	Kg	
Output	Glass Fiber	0.30	Kg	
	Copper Acetate	0.19		
	Iron Scrap	0.0079		

Table S6. LCI data for preparation of 1 kg Ga^4-Mo-GF catalyst

Category	Flow	Value	Unit	Comments
Energy Input	Traditional heating	0.067	kWh	
	Ultra-sonication	0.125		
	Calcination	2		
	Oven drying	0.4		
Material Input	Glass Fiber	1.976	kg	31 % weight loss of glass fiber as per TGA data
	Gallium (III) nitrate hydrate	0.1184		
	Bis(acetylacetonate) dioxo-molybdenum (VI)	0.10967		
	Acetone	0.78		
	Ammonium Hydroxide	0.0257		
Emissions to air	Waste Heat	3.4272	MJ	
	Acetone	0.35	Kg	
Transport	Gallium (III) nitrate hydrate	0.00074	Kg*Km	
	Bis(acetylacetonate) dioxo-	0.000685		

	molybdenum (VI)			
	Acetone	0.0048		
	Ammonium Hydroxide	0.00016		
	Total	**0.00638**		
Output	Ga-Mo-GF catalyst	1	Kg	

Table S7. LCI data for 1kg powdered corncob production

Category	Flow	Value	Unit	Comments
Energy Input	Electricity Consumed	0.55	kWh	
Material Input	Corn Cob	1	kg	
Emission To Air	Waste Heat	1.98	MJ	
Transports	Corn cob	0.00625	Kg*Km	
Output	Powdered Corncob	1	Kg	

Table S8. LCI data for delignification of 1kg of corncob

Category	Flow	Value	Unit	Comments
Energy Input	Electricity Consumed		kWh	
	Magnetic stirring and heating	0.3		
	Ultra sonication	0.125		
	Hot air oven	0.109		
	Total	**0.534**		
Material Input	Powdered Corncob	1	Kg	
	Acetic Acid (98%)	1.36	Kg	
	H_2O_2 (50%)	0.30	Kg	
	DI water	1.5	Kg	
Emission to air	Waste Heat	1.92	MJ	
	Water Vapour	0.075	Kg	
Transport	Acetic Acid (98%)	0.0085	Kg*Km	
	H_2O_2 (50%)	0.00187		
	DI water	0.0093		
	Total	**0.0197**		
Waste of Material	Waste Water	1.435	Kg	
Output	Cellulose	0.3354	Kg	
	Hemicellulose	0.2218		
	Holocellulose	**0.5572**		

Table S9. LCI data for 1kg fermentable sugar production using QHSR

Category	Flow	Value	Unit	Comments
Energy Input	Electricity Consumption		kWh	
	For QHSR	0.1		
	Stirring	0.028		
	Vacuum evaporation	0.1		
	Total	**0.111**	kWh	
Material Input	Holocellulose	1.24	Kg	Considering 90% water recycling after product separation through vacuum evaporation
	Distilled water	1.0	kg	
	Ga^4Mo-GF catalyst	0.186	Kg	
Transport	Distilled water	0.00625	Kg*Km	
Emission to air	Waste heat	0.3996	MJ	
Output	Fermentable sugar	1	kg	

Table S10. LCI data for detoxification and fermentation process for production bioethanol

Category	Flow	Value	Unit

		Neutralization	Over-liming	Solvent extraction	Ion-exchange	
Energy Input	Electricity consumed	3.6	3.6	3.6	3.6	kWh
Material Input	Fermentable sugar	1.462	1.771	1.1	1.11	Kg
	NaOH	0.704				
	$Ca(OH)_2$		0.864			
	Ethyl acetate			0.25		kg
	Amberlite IRP69 resin				Recycled	Kg
Transport		0.0044	0.0054	0.0016	0.002	Kg*Km
Emission to air	Waste heat	12.96	12.96	12.96	12.96	MJ
Output	Bioethanol	0.71	0.69	0.86	1	kg