ANNUAL REPORT
YEAR 1/2 (2011-2013)

Geochem

Project ID: 10-03-005

Coordinator: Bernhard Pálsson / Sigurður Brynjólfsson

Start date: May 1st 2011

Duration: 3 years

Partners:

1 General status of the project

The work has been focused on the control system, controlling the flow of chemicals, the gas flow and composition, power and energy consumption of the LED's. There were a delay in delivering of the control boards from the asian manufacturer and it took longer time than anticipated to test their functionality. The assembly of the prototype for the intial production is ongoing.

The work related to the biology of algae contiues. The adaptive laboratory evolution is a tool that us used to increase the production rate of the algae in the given environment of the photobioreactor. Our main species are *Chlorella vulgaris* and *Dunaliella salina*. *Chlorella* is a common fresh water algae and cultivated as a food suppliment and *Dunaliella* is a salt water algae and is grown for it carotenoid content. It was grown in the photobioreactor using adaptive laboratory evolution and its metabolism investigated. The effect of light intensity, color (red/blue combinations) salinity and type of nitrogen source in the medium. The light combination, ratio of red/blue light, does affect the content of cartenoids in the biomass. This information is used to optimize the economy of the production process.

Recently we started to grow diatom, *Phaeodactylum tricornutum,* in the experimental setup. That organism is promising for producing lipids. It also produce *fucoxanthin* that is used as food suppliment. This organism has been sequenced and therefore it is possible to make a metabolic model that can be used to investigate how applicable it is for production of valuable chemicals and for metabolic engineering. Preliminary results are promishing.

It has not been possible to test teh equipment with geothermal gas. The Center for Systems Biology is located at Sturlugata 8, same building as Decod Genetics. It is not possible to work with geothermal gases in the same facilities as human genetics work is ongoing. It is necessarry to work with geothermal gases closer to or in geothermal area. That has not been done due to to inreased cost. We are trying to resolve that issue in collaboration with other research labs.

Sindri Freyr Ólafsson defended his MS thesis that focused on the final products of chemicals or biomass. Several alternative produciton lines were analysed. That work was in collaboration with Matis (Sigurjón Arason, Hörð Kristinsson, Björn Margeirsson and Sindra Frey Ólafssonar). Final products are lipids and dry biomass. It is possible to produce consumer products later.

1.1 Project progress/time schedule:

Below is a Gantt chart of the project progress.

Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Finalize the design and build a 150L prototype:									1																	1										
Move the 50-150L prototype to a geothermal site										2																			2								
Use geothermal gas as a CO2 source																			3											3						
Design and implement the drying stage																								4												
Design a mass production PBR and build a pilot plant																																				6
Total																																				

Next project year will focus on finalizing the prototype and testing it on geothermal site using real geothermal gases. Adaptive evolution will also continue to increase the growth rate of the algae in the new photo-bioreactor as well as testing new algae that produces other valuable chemicals. Two manuscripts are in progress, one already submitted for publication in a scientific journal.

The people that worked on the project last year where Elín Adda Steinarsdóttir MS mechanical engineering, Weiqi Fu, PhD biochemical engineer, Sindri Freyr Ólafsson MS student industrial engineering, Ólafur Guðmundsson, electrical engineer at Controlant, Daníel Eldjárn BS student electrical engineering, Sigurjón Arason food engineer at Matís, Sigurður Brynjólfsson, PhD, prófessor and project manager. Hörður Kristinsson, PhD and R&D manager at Matis and Björn Margeirsson PhD were also on the MS committee of Sindri Freyr. They were both at Matís at the time.

2 Project Management

Sigurður Brynjólfsson and Bernhard Pálsson are the managers of the project. No big changes are in the project management from the original plans.

3 Student involvement

Sindri Freyr Ólafsson defended his MS project this fall. Daniel Eldjárn, a BS student in electrical engineering, works on the controlling system and the LED electronics. Sigurjón, Hörður and Björn were part of Sindri Freyr MS thesis committee.

Name	Gender	Position/degree	Contribution (mm) 2011/12	Contribution (mm) 2012/13
Elín Adda Steinarsdóttir	F	MS Mech Eng	12	12
Sindri Freyr Ólafsson	M	MS student ME		7
Daniel Eldjárn	M	BS student EE		3
Ólafur Guðmundsson	M	MS Electric Eng	4	1
Weiqi Fu	M	PhD Biochem Eng		4
Sigurður Brynjólfsson	m	PhD Mech Eng	1	1

4 Publications and disseminations

Sindri Freyr Ólafsson *Downstream process design for microalgae,* MS project in industrial engineering Uniersity of Iceland, 2013. http://skemman.is/handle/1946/16441

Fu, W., Guðmundsson, Ó., Paglia, G., Herjólfsson, G., Andrésson, O.S., Palsson, B.Ø., Brynjólfsson, S., "Enhancement of carotenoid biosynthesis in the green microalga Dunaliella salina with light-emitting diodes and adaptive laboratory evolution", Applied Microbiology and Biotechnology, 97(6), pp 2395-2403, (2013) DOI 10.1007/s00253-012-4502-5

Fu, W., Magnusdottir, M., Brynjolfson, S., Palsson, B.Ø., Paglia, G., "UPLC-UV-MSE method for quantification and identification of major carotenoid and chlorophyll species in algae", Anal Bioanal Chem, 404:3145-3154 (2012).

Fu, W., Gudmundsson, O., Feist A. M., Herjolfsson, G., Brynjolfsson, S., Palsson, B. O., "Maximizing biomass productivity and cell density of Chlorella vulgaris by using light-emitting diode-based photobioreactor", Journal of Biotechnology. Volume 161, Issue 3, 31 October 2012, Pages 242–249.

5 Cost statement

Following pages show the cost that has occurred during the first two years. It is mostly salaries. Operational cost is mostly nutriants and minor tools and equipment. Controllant is mostly paid as contractor and that includes LED and electronic equipment..

Consortium:		**CSB-University of Iceland, Matís, Controlant**														
Name of Project:		**Geochem**														
ISK '000	Year		Year 1 2011/2012													
	Month		1	2	3	4	5	6	7	8	9	10	11	12	Total Y1	
Financing																
GEORG funding			425	425	425	425	425	425	425	425	425	425	425	425	5.100	25%
Participants own contributions			540	540	540	540	540	540	540	540	540	540	540	540	6.480	
Participants, in kind costs															0	
Facilites, equipm. & other resources															0	
Other national compet. grants			750	750	750	750	750	750	750	750	750	750	750	750	9.000	
Other intern. Grants, e.g. FP7															0	
Other sources (e.g. Philanthropic)															0	
Total other financing			1290	1290	1290	1290	1290	1290	1290	1290	1290	1290	1290	1290	15.480	75%
Total financing															20.580	
Operational Costs																
Average Personnel Costs		**Unit**														Man-
Participant:		**cost**														months
CSB HI			620	620	620	620	620	620	620	620	620	620	620	620	7.440	13,0
Controlant															0	4,0
															0	0,0
															0	0,0
															0	0,0
															0	0,0
Add lines if needed															0	0,0
															0	0,0
															0	0,0
Total			620	620	620	620	620	620	620	620	620	620	620	620	7.440	17
Operational exp.																
CSB HI			240	240	240	240	240	240	240	240	240	240	240	240	2.880	
															0	
															0	
Total			240	240	240	240	240	240	240	240	240	240	240	240	2.880	
Contracted services																
Controlant			685	685	685	685	685	685	685	685	685	685	685	685	8.220	
															0	
															0	
Total			685	685	685	685	685	685	685	685	685	685	685	685	8.220	
Travel expenses																
CSB UI															0	
															0	
															0	
Total			0	0	0	0	0	0	0	0	0	0	0	0	0	
Others																
CSB UI	overhead		170	170	170	170	170	170	170	170	170	170	170	170	2.040	
															0	
															0	
Total			170	170	170	170	170	170	170	170	170	170	170	170	2.040	
Total operational cost			1.715	1.715	1.715	1.715	1.715	1.715	1.715	1.715	1.715	1.715	1.715	1.715	20.580	

Consortium:		CSB-University of Iceland, Matís, Controlant													
Name of Project:		Geochem													
ISK '000	Year	Year 1 2012/2013													
	Month	1	2	3	4	5	6	7	8	9	10	11	12	Total Y1	
Financing															
GEORG funding		425	425	425	425	425	425	425	425	425	425	425	425	5.100	18%
Participants own contributions		1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.180	14.380	
Participants, in kind costs														0	
Facilites, equipm. & other resources														0	
Other national compet. grants		750	750	750	750	750	750	750	750	750	750	750	750	9.000	
Other intern. Grants, e.g. FP7														0	
Other sources (e.g. Philanthropic)														0	
Total other financing		1950	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950	1930	23.380	82%
Total financing														28.480	
Operational Costs															
Average Personnel Costs	**Unit cost**														Man-months
Participant:															
CSB HI		1.160	1.160	1.160	1.160	1.160	1.160	1.160	1.160	1.160	1.160	1.180	1.180	13.960	19,0
Controlant														0	4,0
Matis		85	85	85	85	85	85	85	85	85	85	85	65	1.000	7,0
														0	0,0
														0	0,0
														0	0,0
Add lines if needed														0	0,0
														0	0,0
														0	0,0
Total		1.245	1.245	1.245	1.245	1.245	1.245	1.245	1.245	1.245	1.245	1.265	1.245	14.960	30
Operational exp.															
CSB HI		230	230	230	230	230	230	230	230	230	230	230	260	2.790	
														0	
														0	
Total		230	230	230	230	230	230	230	230	230	230	230	260	2.790	
Contracted services															
Controlant		550	550	550	550	550	550	550	550	550	550	550	510	6.560	
														0	
														0	
Total		550	550	550	550	550	550	550	550	550	550	550	510	6.560	
Travel expenses															
CSB UI		410					410							820	
														0	
														0	
Total		410	0	0	0	0	410	0	0	0	0	0	0	820	
Others															
CSB UI		280	280	280	280	280	280	280	280	280	280	280	270	3.350	
														0	
														0	
Total		280	280	280	280	280	280	280	280	280	280	280	270	3.350	
Total operational cost		2.715	2.305	2.305	2.305	2.305	2.715	2.305	2.305	2.305	2.305	2.325	2.285	28.480	