AQUACULTURE OF MICROALGAE IN NEW-CALEDONIA (AMICAL): DEVELOPMENT OF A CO_2 SUPPLY DEVICE FOR INTENSIVE MICROALGAE CULTURE. ASSESSMENT OF THE DEVICE WITH CARBON BUDGET OF CULTURES IN MICROCOSM.

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Introduction

Aquaculture diversification has been set as a major policy by New Caledonia public authorities. In this context, the development of micro-algae cultures has been identified as a priority. The study presented has been co-funded by Glencore company in New Caledonia and achieved under the program «Aquaculture of MIcro-algae in new-CALedonia» (AMICAL). The intensive microalgal cultivation requires additional CO_2 (1) which is expensive; thus optimizing the supply of this gas is a priority.

Objectives

(i) designing a device to bring dissolved CO_2 into microalgae cultures with a minimum loss in atmosphere;

(ii) to assess this device by carrying out carbon budget of microalgae cultures in microcosm.

Material and method

Development of the CO_2 saturator device. Figure 4B shows the schematic flow of the device. The laboratory and the pilot scale devices are based on the same principle. The apparatus consists of a tube filled with beads; CO_2 and water are introduced at one end of the tube and the water saturated with CO_2 is recovered at the other end. The beads in the tube, lengthen the water residence time with the CO_2 and increase the exchange surface between the two elements.

Carbon budget assessment (2). The microcosm consists of a 2 liters flask (Pyrex) closed with a silicone cork comprising three orifices in which are inserted three glass tubes immersed in the culture medium (Figure 2). Sampling and CO_2 injection is done by two of these tubes, the third tube serves as a vent. the sampling is carried out using a syringe with a capacity of 50 ml; two 70ml samples are taken daily. The measures carried out on the samples are: optical density, cell concentration, pH and total alkalinity. The day before the experiment, the microcosms are filled with culture of microalgae from photobioreactor (Figure 1).

During the experiment, the cultures in microcosms was subjected to an irradiance of 85µmol.m^{-2} · s^{-1}. The temperature of the culture was maintained at 28 °C with a water bath (Figure 2). The carbon and nitrogen cellular content were determined using a CHN (300 Eager, Thermo Scientific). The CO_2 in the culture was determined indirectly by measuring the pH and the total alkalinity.

Figure 1 : culture of microalgae in a photobioreactor.

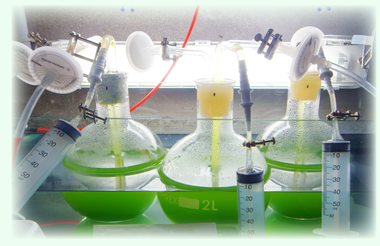
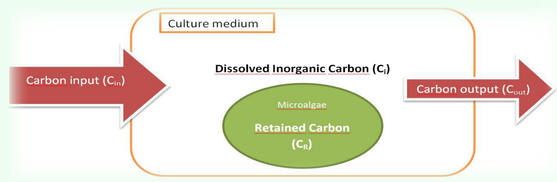


Figure 2 : culture of microalgae in microcosm to achieve the carbon balance.



$$C_{in} = C_R + C_i + C_{out}$$

Figure 3 : conceptual model and carbon balance equation.

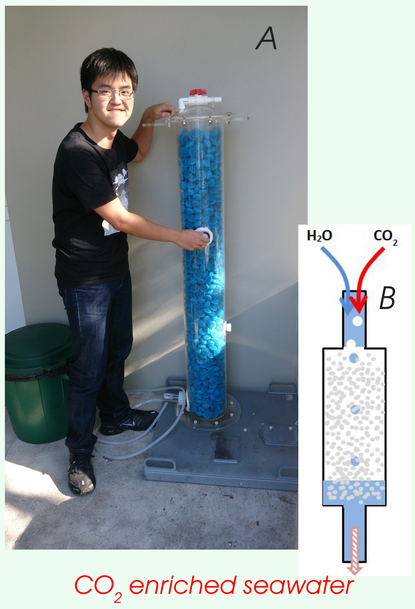


Figure 4 : pilote scale device (A) and schematic flow (B)

Results and conclusion

After assessment of 3 devices at the laboratory scale, the most efficient one have been built at a pilot size (Figure 4A).

The CO_2 enrichment of the culture medium was faster with CO_2 saturated water compared with a conventional CO_2 bubbling (Table 1)

Table 2 summarizes the carbon budgets obtained with both CO_2 supply systems. The required amount of CO_2, in dissolved form, is 60% lower than in gaseous form. The amount of carbon retained by microalgae is 92% higher when the CO_2 is introduced in the dissolved form. The higher carbon sequestration rate, when CO_2 is brought in dissolved form, resulted in an increase in the C / N ratio of the microalgae; the later is likely due to accumulation of lipids or carbonhydrates.

Finally, the device developed in this work, compared to conventional bubbling device, has improved 10 times the transfer of carbon in microalgae.

Table 1 : CO_2 enrichment rate in the culture medium, depending on the input method, bubbling *versus* concentrator.

Treatments	CO_2 ($mg.L^{-1}.min^{-1}$)
Bubbling	3,10
ESW(1)	19,30

(1) CO_2 Enriched Sea Water

Table 2 : balance of CO_2 assessed at the end of culture period.

Treatments	Carbon balance (mg CO_2)				
	C_{in}	C_R	C_i	C_{out}	Yield = C_R/C_{in} (%)
Bubbling	1214	78	<1	x	6
ESW	485	367	<1	x	76

C_{in} = Carbon input
C_R = Carbon retained
C_i = Inorganic dissolved carbon
C_{out} = Carbon output (not measured)

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References

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