

TECHNOLOGY CULTURING SPIRULINA PLATENSIS ALGAE BY LAVIE'S NATURE WATER

CÔNG NGHỆ NUÔI CẤY TẢO SPIRULINA PLATENSIS BẰNG NGUỒN NƯỚC LAVIE TRONG TỰ NHIÊN

Trinh Van Dung, Nguyen Le Huong

Bach Khoa University, Vietnam National University, Ho Chi Minh City, Vietnam

Received 25/5/2017, Peer reviewed 01/7/2017, Accepted for publication 15/8/2017

ABSTRACT

This article presents the results of a simplex algorithm to minimize the medium culture cost of Spirulina platensis (S. platensis) from the natural mineral water source LaVie, Long An. The results showed that the cost of nutrient culture of S. platensis with LaVie mineral water can be decreased to 95,76 VND per liter. The improved nutrient culture of S. platensis from LaVie mineral water including $25 \div 40$ oC of temperature, $8,5 \div 10,2$ of pH value, the concentration of biomass reached 1,0 grams per liter after 7 days of incubation. In comparison of the same incubation conditions with Zarrouk medium, the growth rates of S. platensis in different medium were similar. These basic results will be used for the production of S. platensis from LaVie natural mineral water in industrial scale.

Keywords: Water, LaVie mineral water, algae, S. platensis; optimization of algal nutrient culture's cost; simplex algorithm

TÓM TẮT

Bài báo trình bày kết quả dùng thuật toán đơn hình để tối thiểu hóa chi phí môi trường dinh dưỡng nuôi tảo Spirulina platensis (S. platensis) từ nguồn nước khoáng thiên nhiên LaVie Long an. Kết quả cho phép giảm chi phí môi trường dinh dưỡng nuôi tảo S. platensis bằng nước khoáng LaVie là 95,76 đồng/lít. Môi trường cải tiến từ nước khoáng LaVie được kiểm chứng khi nuôi tảo S. platensis, ở điều kiện nhiệt độ thay đổi trong khoảng khá rộng từ $25 \div 40$ °C; pH trong khoảng $8,5 \div 10,2$; nồng độ sinh khối tảo đạt được 1,0 gam/lít sau 7 ngày. So sánh với tốc độ tăng trưởng của tảo S. platensis nuôi bằng môi trường Zarrouk ở cùng điều kiện cho kết quả tương đương nhau. Đây là cơ sở để triển khai sản xuất tảo S. platensis công nghiệp từ nước khoáng thiên nhiên LaVie.

Từ khóa: Nước; Nước khoáng LaVie; tảo S. platensis; tối ưu hóa chi phí môi trường nuôi tảo; tối thiểu hóa chi phí môi trường nuôi tảo.

1. INTRODUCTION

Spirulina (algae) - S. platensis which has high nutritional value, is widely used in food and medicine. In addition, the cultivation of algae in general and S. platensis in particular

which has the effect of protecting the medium and combating the climate change. When there is enough nutrient in the form of bicarbonate (HCO_3^-), as well as micronutrient, and polyprotein, S. platensis synthesizes

biomass by solar photo-catalysis. Therefore, to producing 1000 kg of dry algae will consume 450 kg of CO₂ known as greenhouse gas, generate 1200 kg of oxygen [6]. Numerous studies showed that *S. platensis* grows and synthesizes good biomass in Zarrouk medium [1, 3, 6, 7]. However, due to the cost of the algae culture Zarrouk medium is quite large, the growing of this algae on an industrial scale is not economical. [2] Meanwhile, we can use the unsafe materials for algae, as well as food and medical. To overcome this disadvantage, it is necessary to look for the suitable and low cost nutrient medium with *S. platensis* while using the clean and cheap natural Vietnam mineral resources. We have built the minimizing of the nutritive medium of algae *S. platensis* from LaVie Long an mineral water by simple method. This is the basis for the production of *S. platensis* in the industrial scale.

2. MATERIALS AND METHODS

2.1 Laboratory equipment

Glass vase (250 ml), erlen (250 ml), volumetric flask (100 and 500 ml), pipette (2 and 10 ml), laboratory weighing, graduated cyclinder (250 ml).

Some other tools: Wine thermometer (0 ÷ 100⁰C, made in France); pH meter (Hanna, model HI98172); measurement of algal concentration by US Beckman Coulter DU 750 spectrometer at 750 nm, biomass conversion coefficient for *S. platensis* was 0,73 [4, 5].

2.2 Algae culture medium used in laboratory

The *S. platensis* used in the experiment was purchased from the Department of Experimental Biology, Institute of Aquaculture No. 2 (116 Nguyen Dinh Chieu Street, Da Cao Ward, Dist. Ho Chi Minh).

LaVie Mineral Water is mineral water from Khanh Hau, Tan An, Long An. 239 of code for mineral water.

The control culture medium is Zarrouk medium [1, 6, 7] which has the substrate, micro-nutrient, multi-nutrient content for *S. platensis*, given in Table 2.

Table 1. LaVie mineral water composition used in the experiment [6]

Ion	Anion	mg/l	mge/l	cation	mg/l	mge/l
1	HCO ₃ ⁻	176,96	2,90	Na ⁺	86,39	3,76
2	CO ₃ ²⁻	18,00	0,60	K ⁺	-	-
3	Cl ⁻	157,75	4,45	Ca ²⁺	46,09	2,30
4	SO ₄ ²⁻	12,01	0,25	Mg ²⁺	26,14	2,15
5	NO ₃ ⁻	0,39	0,01	Fe ²⁺	-	-
	Tổng:	365,11	8,21	Tổng:	158,62	8,21

Table 2. Zarrouk medium composition used in control experiments [3,5]

No	Công thức hóa học	Zarrouck, g/lít
1	NaHCO ₃	16.8
2	K ₂ HPO ₄	0.5
3	NaNO ₃	2.5
4	NaCl	1.0
5	K ₂ SO ₄	1.0
6	MgSO ₄ ×7H ₂ O	0.2
7	FeSO ₄ ×7H ₂ O	0.01
8	CaCl ₂ ×2H ₂ O	0.04
9	Fe-EDTA	1,0 ml/lít
10	Dung dịch vi lượng 1	1,0 ml/lít
11	Dung dịch vi lượng 2	1,0 ml/lít

2.3 Research methodology

2.3.1 The cost of nutrient culture of algae *S. platensis* from LaVie mineral water minimized by simplex algorithm

Comparison of the data in Table 1 and Table 2 shows that Lavie mineral water contains a lot of minerals (HCO₃⁻, NO₃⁻, SO₄²⁻,

Table 3. The results of the calculation of the matrix coefficients a_{ji} , vector b_j , c_i and the solution of the optimal problem solved by simplex algorithm [4]:

TT	Công thức	NaHCO ₃	NaNO ₃	K ₂ HPO ₄ .3H ₂ O	K ₂ SO ₄	NaCl	MgSO ₄ .7H ₂ O	FeSO ₄ .7H ₂ O	CaCl ₂ .6H ₂ O	b_i
	Khoáng	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	
1	HCO ₃ ⁻	0.72619	0	0	0	0	0	0	0	12.02304
2	NO ₃ ⁻	0	0.72941	0	0	0	0	0	0	1.82314
3	Na ⁺	0.27381	0.27059	0	0	0.3932	0	0	0	5.58324
4	K ⁺	0	0	0.34211	0.4483	0	0	0	0	0.61933
5	HPO ₄ ²⁻	0	0	0.42105	0	0	0	0	0	0.21053
6	SO ₄ ²⁻	0	0	0	0.5517	0	0.39024	0.00071	0	0.61777
7	Cl ⁻	0	0	0	0	0.607	0	0	0.32420	0.46206
8	Ca ²⁺	0	0	0	0	0	0	0	0.18265	0.03878
9	Mg ²⁺	0	0	0	0	0	0.09756	0	0	0.00663
10	Fe ²⁺	0	0	0	0	0	0	0.03966	0	0.00040
Giá c_i , VND/gam		76	150	104	148	62	90	70	70	Chi phí, VND $f(X) \rightarrow$ Min
X, g/lít		15.54	2.5	0.5	1	1	0.2	0.01	0.04	1839.54
Zarrouk, g/lít		16.8	2.5	0.5	1	1	0.2	0.01	0.04	1935.3

Table 4. The composition of improved medium from LaVie mineral water.

Công thức	NaHCO ₃	NaNO ₃	K ₂ HPO ₄ .3H ₂ O	K ₂ SO ₄	NaCl	MgSO ₄ .7H ₂ O	FeSO ₄ .7H ₂ O	CaCl ₂ .6H ₂ O	EDTA	vi lượng 1	vi lượng 2
Lượng g/lít	6.72	2.50	0.50	1.00	1.00	0.20	0.01	0.04		1,0 ml/lít	

3.2 The variable temperature of culture medium

The temperature of the culture medium depends on the weather. With rainy days, sunny days and overcast days, the results which are shown in Table 2 and Figure 2, vary strongly.

From the data given in Table 5, the temperature of the day increased sharply from 6am to 8am, and not much changed from 8am to 16pm. On the sunny days, even rainy days, the temperature that exceeds the optimal value for *S. platensis* (30 ÷ 38°C). And, it also has risen to a dangerous temperature (40°C).

Table 5. The change of algal culture temperature (in P. 25, Binh Thanh District, HCMC)

τ , giờ	Ngày	5	6	7	8	9	10	11	12	13	14	15	16	17	18
t, °C	Mưa	25	27	33	34	34	35	33	34,5	35,5	38	39	40	37,5	28
	Râm	24	26	28	32	36	37	37,5	37	35	36	34,5	31	31,5	29
	Nắng	25	30	35,5	37	36,5	40	39	38,5	40	42	37,5	38	36	30

But for a short time, then it is necessary to shake the algae culture medium, from 10 hours to 16 hours.

3.3 Biological growth rate (OD₇₅₀) and pH of algae culture medium

The variation of the OD₇₅₀ was measured in Table 6 and Figure 1.

From the results showed that *S. platensis* began to grow rapidly after 3 days and slow down after 6 days. The reason is the reduction of nutrient in the medium, and the high pH (10,0). This result causes the slow algae's growth rate. After 7 days, the biomass concentration was about 1,0 grams per liter.

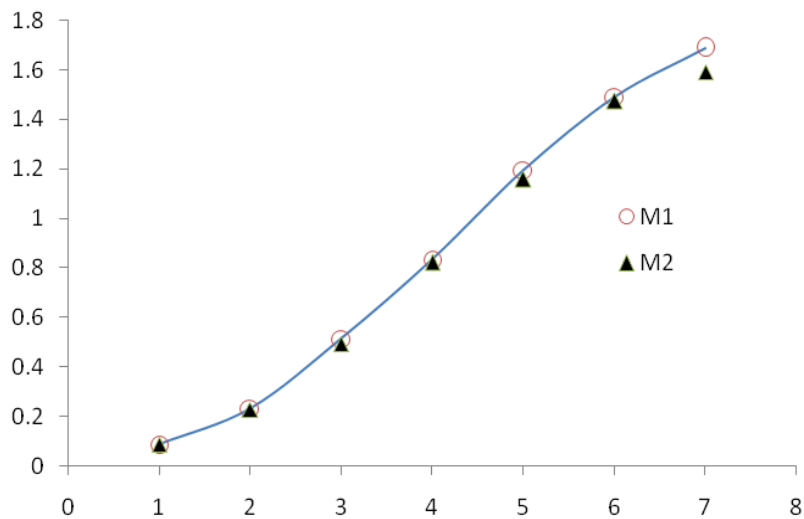


Figure 1: The variation of OD₇₅₀ over time.

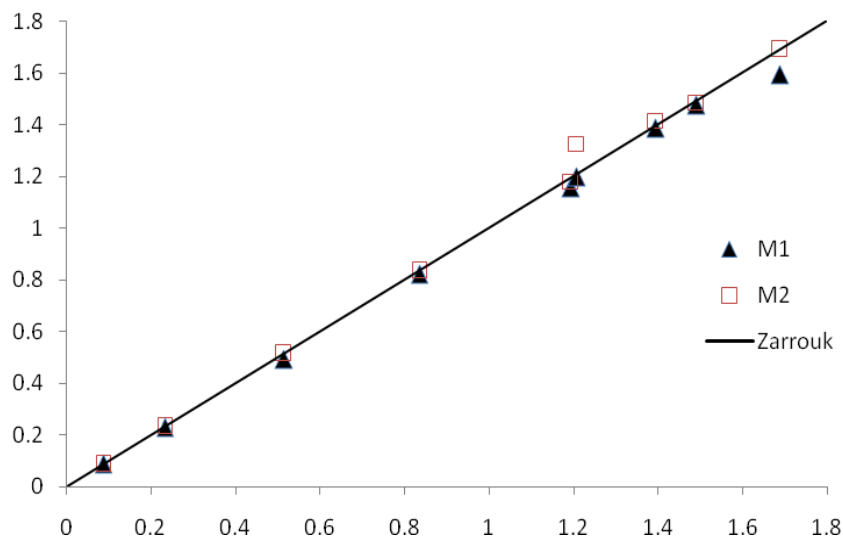


Figure 2. The variation of OD₇₅₀ of *S. platensis* which cultured in medium from LaVie and Zarrouk medium

3.4 Compare the growth ability of *S. platensis* in the medium from LaVie and in the Zarrouk medium

In figure 2, the rate of change of OD₇₅₀ of *S. platensis* in the culture medium from LaVie (shown in Table 4) mineral water and the Zarrouk medium (shown in Table 2) are similar in the same condition.

4. CONCLUSIONS

The growing of algae *S. platensis* by mixing with LaVie mineral water has obtained the clean product and the effective

use of natural mineral resources in the country.

The growth rate of algae *S. platensis* by the medium from LaVie mineral water is quite good. After 7 days, the biomass concentration can reach to 1.0 grams per liter.

The growth and development of *S. platensis* by the culture medium from LaVie mineral water and Zarrouk medium are similar.

The amount of mineral utilized from LaVie mineral water is 95.76 VND per liter, about 5% compared to the Zarrouk medium.

REFERENCES

- [1] Lê Văn Lăng, Tảo Spirulina, *Medical Publishing House, HCMC*, (1999) 162.
- [2] Nguyễn Minh Chu, Nguyễn Văn Cảnh, L Thị Nhn, Nguyễn Anh Dũng, Đặng Hồng Diễm, Nguyễn Văn Duy, Nguyễn Thanh Sơn, Khuất Hữu Thanh, Nghiên cứu sử dụng nguồn nước khoáng để xây dựng quy trình sản xuất tảo Spirulina platensis đảm bảo chất lượng làm nguyên liệu chế biến thức ăn cho người và động vật nuôi thủy sản, *Báo cáo tổng kết đề tài DT20144190, The library of Ministry of agriculture and Rural development*.
- [3] Nguyễn Hữu Thuốc, Nguyễn Tiến Cư, Đặng Hoàng Phước Hiền, Đặng Đình Kim, Thực nghiệm nuôi trồng liên tục tảo Spirulina platensis ở tỉnh Thuận Hải, *Journal of Biology*, 2 (1980) 12-14.
- [4] Võ Công Nghiệp, Danh bạ các nguồn nước khoáng- nóng Việt Nam, *NXB Bộ công nghiệp, Cục địa chất và khoáng sản Việt Nam, Hà Nội* (1998) 20.
- [5] Trịnh Văn Dũng, Ứng dụng tin học trong Công nghệ Hóa học – Sinh học – Thực phẩm, *Vietnam National University Publishing House, HCMC*, (2016) 317.
- [6] S. A. Kedik, E. I. Yartsev, N. In. Gulyaeva, Spirulina is the food of the XXI century, *Farm Center Publishing House*, 2006, 215 c. (ISBN 5-901913-03-5).
- [7] Zarrouck, C. Contribution a l'étude d'une cyanophyce. Influence de divers physiques et chimiques sur la croissance et la photosynthese de Spirulina maxima/C, *Zarrouck's Ph.D. thesis, Paris*, (1966) 138.
- [8] Indice prologo estanques factores climaticos medio de cultivo inoculacion cosecha como alimentar el cultivo atenciones del cultivo conservacion secado consumo anexo concentracion salinidad alcalinidad ph humedad, *Cultivo Artesanal de Spirulina* (Resumen de la version francesa), Paris, (2010), 212.
- [9] M. E. Gerswin and Amha Belay Spirulina in Human Nutrition and Health. *Taylor & Francis Group CRC Press, Boca raton – London – New York*, (2007) 305.

Corresponding author:

Prof. Dr. Trinh Van Dzung

Bach Khoa University – Vietnam National University, Ho Chi Minh City, Vietnam

Email: dungtv@hcmute.edu.vn