MICROALGAE

The Future of Omega- 3 Fatty Acids in Aquaculture

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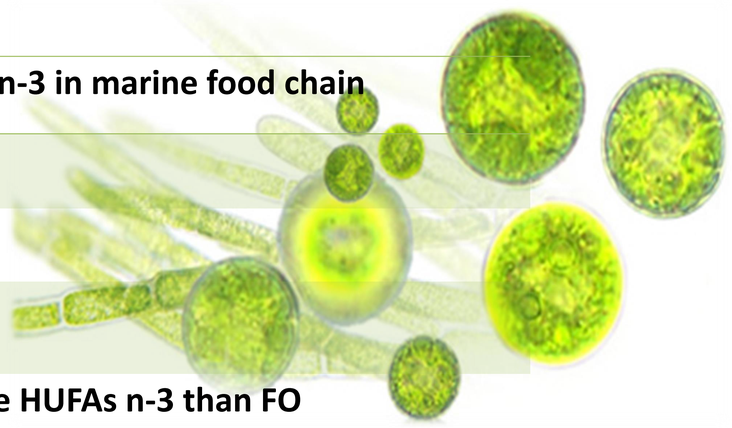
INTRODUCTION

The significant role of omega-3 fatty acids in the organism and our inability to synthesize them efficiently, has led to an increased demand in the finfish industry to offer these compounds in our diets. Fish oil (FO) is the main source of omega-3 in this industry, but its production begins to be insufficient to sustain the sector's growth. We need to search for alternatives that enable the expansion of aquaculture to meet the social demand but still, assure omega-3 fatty acids in marine finfish and consequently in our diets.

OBJECTIVES

This work intends to summarize the role of microalgae as the new alternative source of omega-3 for the marine organism production, considering both the achieved milestones and the pending issues awaiting scientific and technique development.

WHY MICROALGAE?



- **Primary producers of HUFAs n-3 in marine food chain**
- **Fast growth**
- **Simple culture requirements**
- **Simple DNA**
- **More stable and bioavailable HUFAs n-3 than FO**

STRATEGIES

OBJECTIVE >> IMPROVE HUFAS n-3 and Biomass production

1. STRAIN SELECTION

Omega-3 fatty acids content in microalgae is species-especific, so strain selection is important. Moreover, as **most of the aquaculture strains are rich in EPA, new strains with higher DHA levels are being considered** (Table 1)

Microalgae		EPA	DHA
Aquaculture strains (Phototrophic strains)	**Nannochloropsis sp.**	**++++**	-
	Pavlova lutheri	**+++**	++
	Phaeodactylum tricornutum	**+++**	-
	Thalassiosira pseudomona	**+++**	+
	Isochrysis T-iso	-	++
	Tetraselmis suecica	+	-
	Porphyridium cruentum	+	-
Others (Heterotrophic strains)	**Crypthecodinium sp**	-	**++++**
	Schizochytrium sp	-	**++++**

Table 1.- Levels of EPA and DHA in different microalgae strains

2. IMPROVEMENT OF MASS CULTURE

CHALLENGES

1) Opposite cultivation conditions for HUFAs n-3 and biomass

HUFAs n-3 improvement >>>>>>> **low temperature // low light**
Biomass improvement >>>>>>>>> **optimum temperature // optimum light**

A posible solution could be **multistage cultivation strategy.** The concept is to ensure maximum growth (biomass production) in one stage of the microalgal culture, and maximumm HUFAs n-3 production in another stage. Therefore two culture systems must be combined, so each one will apply the conditions needed for each stage (Fig.1).

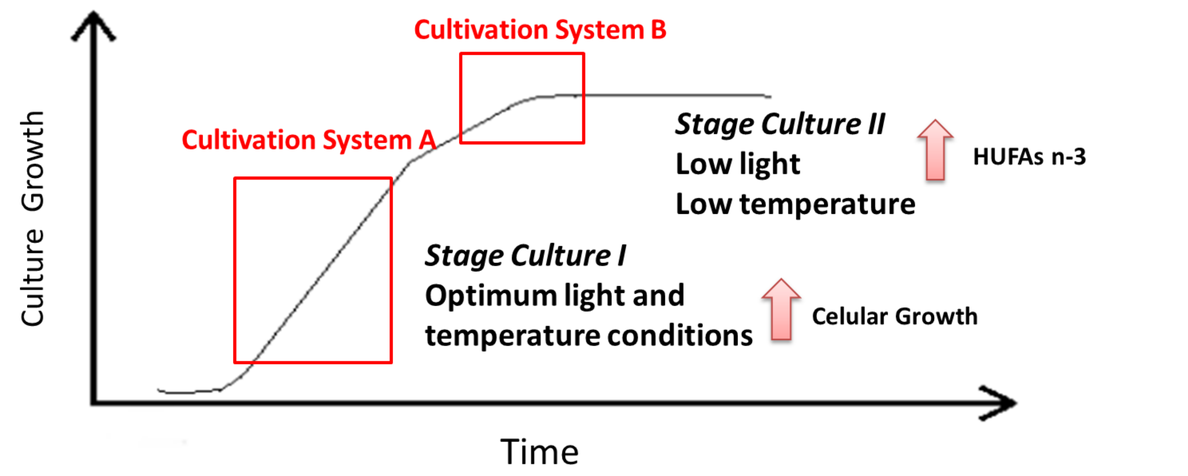


Figure 1.- Esquematic performance of the multistage cultivation strategy

2) High production cost of Photobiorreactors (PBRs)

PBRs are the most commonly used cultive systems for marine phototrofic algae mass cultivation. Actually, their cost production, makes high mass cultivation of microalgae economically unfeasible.

Actually a new generation Low- cost PBRs are being studied to attempt this problem (Fig.2)(Fig.3)

Figure 2.- GreenWall Pannel PBR

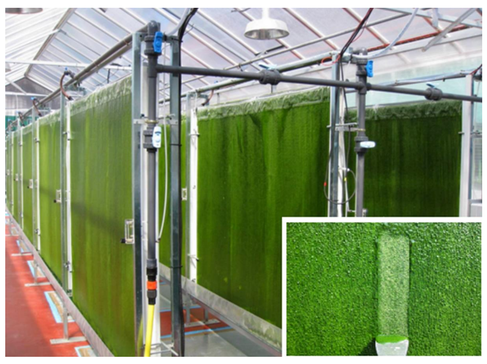


Figure 3.- Laminar PBR

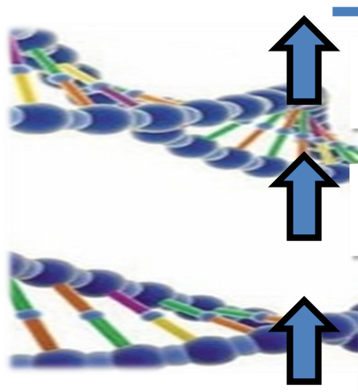
3. METABOLIC ENGINEERING

Most of the information available is based in other microorganisms rather than in microalgae aquaculture strains.

Actually the future trends are pointed to:

1) Optimize the Aerobic Desaturasa and Elongasa Pathway to enhance HUFAs n-3 production

HOW?



Aerobic Pathway efficiency
Using acil-CoA type of Δ6 Desaturasa

Omega- 3 fatty acid pathway synthesis
Improving Δ15, Δ17 and Δ19 Desaturasas activity

DHA synthesis over EPA
Improving Δ5 Elongasa activity

2) Decode genes in order to **find molecular markers of production** in some strains

CONCLUSIONS

Microalgae actually are the major candidates for FO replacement in aquaculture. In order to achieve this purpose, *three strategies* are being applied:

1. ***Strain selection:*** **New microalgae strains are being studied for aquaculture due to their high levels of DHA**
2. ***Improvement of mass culture:*** **Multistage cultivation strategy should be applied, and cheaper PBRs must be developed to achieve feasible mass production of microalgae,**
3. ***Metabolic engineering:*** **is recent in aquaculture microalgae. Some techniques to enhance the Aerobic Pathway have recently been applied to improve HUFAs n- 3 production with successfully results.**