

Algal Biotechnology

»ÃĐÇŃμÔ (Background)

ÊÔËÃèÒÃËà»ÃÛÃÔ¹èÒ (Spirulina) à»ç¹áËËËâ»ÃμÔ¹áÃĐÃÔËÔÃà»ÃÔÃÛÃμèÒËÛS ``Ó¾Çj;Ã´àÇÃŃ¹´´Óà»ç¹ àªè¹ jÃ´ÃÔã¹ÃÔ¾Çj; »ÃíãÃ¿ÔÃÃi.ÔèãËéËÔàÇÔÃÇ à¿ã»à«ÃÔ¹Ô¹ãËéËÔ¿èÒ áÃĐã»ãÃ.Ô¹Ã´¹.ÔèãËéËÔËéÃá´S «ÔèSËÔÃÔÃ¶Ëj;Ń´ÊÔÃËÔãàáÃĐà»Ã×èíSËÔÍÒS

j;ÃĐèÃÇÔ´ŃÃà.ªã¹ãÃÃÔªÔÇÃÔ¾ÊÔËÃèÒÃ (Algal Biotechnology) à»ç¹Ë¹èÇÃSÔ¹Ë¹ÔèSã¹ R&D Cluster ÁËÔÇÔ.ÃÔÃŃÃà.ªã¹ÃèÇÃj;Ńº¹Ńj;ÇÔ´ŃÃÇíSË¶ÔºŃ¹¾Ń²¹ÔãÃĐ½Ôj;ÍºÃÃÃSSÔ¹μé¹áºº ÁËÔÇÔ.ÃÔÃŃÃà.ªã¹ãÃÃÔ¾ÃĐ´´Ãàj;ÃéÒ,¹ºĐÃÔ áÃĐ¹Ńj;ÇÔ´ŃË¹Ãi¾Ń¹,ØÇÔËÇj;ÃÃÃáÃĐà.ªã¹ãÃÃÔªÔÇÃÔ¾áËèSªÔμÔ á´ÃãÃÔèÃj;ÔÃ´Óà¹Ô¹SÔ¹»ÃĐÃÔ³»Ô¾.Ë. 2530 ´éÇÃã»ÃSj;ÔÃ´“j;ÔÃ¹Ó¹éÓ.Ôés´Ôj;ãÃSSÔ¹á»ésÃŃ¹ËÔ»ĐËÃŃSÃÔà»ç¹áËËËíÔËÔÃà¾×èíãªéãÃÔèÃSËÔËÃèÒÃËà»ÃÛÃÔ¹èÒ”;(BIOTEC) áÃĐã´é´Óà¹Ô¹j;ÔÃÇÔ´ŃÃ´éÔ¹j;ÔÃà¾ÔĐàÃÔèÃSËÔËÃèÒÃ Ëà»ÃÛÃÔ¹èÒ j;ÔÃ¾Ń²¹ÔËÔÃ¾Ń¹,Øj;μÃÍ´¹.Ôj;ÔÃÇÔ´ŃÃã¹ÃĐ´ŃªªÔÇãÃãÃj;ØÃàj;ÔèÃÇj;Ńºj;ÔÃáË´SÍj;ÇíSÃÔ¹áÃĐãÍç¹ã«Ãi.Ôèàj;ÔèÃÇÇéíSj;Ńºj;ÔÃËŃSà»ÃÔĐËiËÔÃã»

ã¹»Ô¾.Ë. 2545 ËÛ¹Ãi¾Ń¹,ØÇÔËÇj;ÃÃÃáÃĐà.ªã¹ãÃÃÔãËèSªÔμÔ ÃèÇÃj;Ńºj;ÃĐèÃÇÔ´ŃÃà.ªã¹ãÃÃÔªÔÇÃÔ¾ÊÔËÃèÒÃ´Ń´μã´ÃÃÔã»éÔËÃÔÃà¾×èí¾ŃŃj;Ń¹ãËéãj;Ô´ÇÔÃÃèÇÃÃ×ÃĐËÇèÔSÃÔªÃj;ª¹áÃĐj;ÃĐèÃÇÔ´ŃÃi à¾×èíãËéãj;Ô´à»Ã×íÇèÒÃ j;ÔÃà¾×èíà¾ÔèÃ»ÃĐËÔ,ÔÃÔ¾j;ÔÃ¹ÃÔμÇíSÃÔªÍØμËÔËj;ÃÃÃ ÁÇÃ¶ÔSj;ÃĐèÃÇÔ´ŃÃËÔÃÔÃ¶¹ÃÔμSÔ¹ÇÔ´ŃÃãËéμÃSμéÍÇÔ

ÇŃμ¶Ø»ÃĐËSà

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¾Ń²¹Ôà.ª¹Ôªj;ÔÃà¾ÔĐàÃÔèÃS áÃĐ¾Ń²¹ÔËÔÃ¾Ń¹,Øj;ÔèÃÔªØ³ªèÒàªÔS¾Ô³ÔªÃi

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ËÔj;ËÔj;ÔÃËŃSà»ÃÔĐËiËÔÃà»ÃÔÃÛÃμèÒËÛSã¹ËÔËÃèÒÃËà»ÃÛÃÔ¹èÒ

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ãªéËÔËÃèÒÃËà»ÃÛÃÔ¹èÒà»ç¹ãÃà´ÃÇíS¾×ª ÊÓËÃŃºj;ÔÃËÔj;ËÔj;ÔÃμÍºË¹íSμéíÃÔÇĐj;´Ń¹ (stress respond) ·ŃéSj;ÔÃËŃSà»

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ËèSàËÃÔÃãËéãj;Ô´ÇÔÃÃèÇÃÃ×ÃĐËÇèÔSÃËÔÇÔ.ÃÔÃŃÃãÃĐË¹èÇÃSÔ¹ãÍª¹ÃÔªÍØμËÔËj;ÃÃÃ.Ôèàj;ÔèÃÇj;Ńºã.ªã¹ãÃÃÔ

SÔ¹ÇÔ´ŃÃãÃĐ¾Ń²¹ÔÇíSj;ÃĐèÃà¹é¹ 3 á¹Ç.ÔSËÃŃj;´ŃS¹Ôé

1. j;ÔÃà¾ÔĐàÃÔèÃS (Mass Cultivation)

ÃĐèSà¹é¹ãËéã´é¹Ã¹ÃÔμãÃĐ»ÃĐãÃª¹´Ôj;¾Ã¹ÃÔμÃÔj;ÔèËØ´ ÁÔSÔ¹ÇÔ´ŃÃ¶ÔS¾ÃÇíS»Ń´ŃÃËÔèSáÇ´ÃéíÃμéíj;ÔÃà´ÃÔ-ÇáÃĐj;ÔÃËÔj;ËÔ´éÔ¹ÔÃ´ÓÃíS.ÔSª³ÔμËÔËμÃi (math model) ÇíSÃĐª¾ÔĐàÃÔèÃS

2. ÊÒÃà¼ÁÕÁÙÀ¼èÒÊÙ\$ (High Value Chemicals)

ÁÕ¡ÒÃ´Òà¹Ô\$Ô¹ÇÔ´ÑÃà¾¼×èÍãÊéà¡Ô´Í\$¼¼ÇÒÁÃÙéà¡ÕèÃÇ¡Ñ°ÊÒÃà¼ÁÕÁÙÀ¼èÒÊÙ\$ã¹ÊÒÊÃèÒÂÊä»ÃÙÀÔ¹èÒ á´ÂÊÖ¡ÊÒ
à°è¹ ÁÔ»Ô´ÊÃ×Í GLA ä¿â¼ã«ÃÒ¹Ô¹ áÃÐâ¾¼ÃÕá«¼¼ÒäÃ´´Ò¡ÊÒÊÃèÒÂÊä»ÃÙÀÔ¹èÒ ÃÇÁ¶Õ\$¡ÒÃÊÖ¡ÊÒ¼Ø³Ê°ÑµÔ¡ÒÃà»ç

3. ¡ÒÃÊÖ¡ÊÒ´éÒ¹ªÕÇâÃàÃ¡ØÃ (Molecular biology)

ÁØè\$à¹é¹ãÊéà¡Ô´¼ÇÒÁÃÙé¼ÇÒÁà¢éÒã´´éÒ¹ÊÃÕÇÔ·ÃÒ¢Í\$ÊÒÊÃèÒÂÊä»ÃÙÀÔ¹èÒ ÃÇÁ¶Õ\$¡ÒÃ¡¡¡¡ÒÃ¼Ç°¼ØÁ áÃÐ¡ÒÃÊÑ\$ã
Proteomic Genomic áÃÐ In silico Spirulina modeling

¡ÒÃ¶èÒÃ·Í·à·¼â¹âÃÃÕ

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à·¼â¹âÃÃÕ¡ÒÃà¾¼ÒÐàÃÕéÃ\$ áÃÐ¡ÒÃÍ¡á°ÃÐ°°

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¡ÃÐ°Ç¹¡ÒÃÊ¡Ñ´ÊÒÃà¼ÁÕÁÙÀ¼èÒÊÙ\$´Ò¡ÊÒÊÃèÒÂÊä»ÃÙÀÔ¹èÒ

¡ÒÃ°ÃÔ¡ÒÃ

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ãÊé¼Ó»ÃÕ¡ÊÒ

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°ÃÔ¡ÒÃµÃÇ´ÇÒà¼ÃÒÐÊì¼Ø³ÃÒ¾¼ÊÒÊÃèÒÃ

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“ $\tilde{N}^{\frac{1}{2}}\ddot{O}_j\acute{I}^{\circ}\tilde{A}\acute{A}_j\grave{e}^1\tilde{N}_j\grave{C}\acute{O}^a\grave{O}_j\grave{O}\tilde{A}\grave{A}\grave{O}\grave{a}\acute{I}_j^{a1}\tilde{A}\grave{C}\acute{A}\cdot\tilde{N}\acute{e}\S^{\circ}\emptyset\grave{m}\grave{A}\cdot\ddot{O}\grave{e}\acute{E}^1\grave{a}^{\cdot}\grave{m}^1\acute{O}\grave{m}\acute{a}\grave{D}\acute{E}\tilde{A}\tilde{N}_j;\grave{O}\tilde{A}_j;\grave{O}\tilde{A}\grave{a}\frac{3}{4}\grave{O}\grave{D}\grave{a}\tilde{A}\tilde{O}\acute{e}\tilde{A}\S$

$\acute{E}\grave{O}\tilde{E}\tilde{A}\grave{e}\grave{O}\tilde{A}\tilde{E}\grave{a}\rangle\tilde{A}\grave{U}\tilde{A}\tilde{O}^1\grave{e}\grave{O}$ (ÍÒÃìâ,ÃÊä»ÃèÒ)

$\acute{E}^1\tilde{N}\S\acute{E}\times\acute{I}\acute{E}\grave{O}\tilde{E}\tilde{A}\grave{e}\grave{O}\tilde{A}\tilde{E}\grave{a}\rangle\tilde{A}\grave{U}\tilde{A}\tilde{O}^1\grave{e}\grave{O}$ (ÍÒÃìâ,ÃÊä»ÃèÒ) $\acute{A}\tilde{O}\grave{a}^1\times\acute{e}\acute{I}\acute{E}\grave{O}^{\cdot}\acute{e}\grave{O}^1\grave{m}\grave{C}\grave{O}\tilde{A}\tilde{A}\grave{U}\acute{e}\cdot\tilde{N}\grave{e}\grave{C}\grave{a}\rangle\grave{a}_j\ddot{O}\grave{e}\tilde{A}\grave{C}_j\tilde{N}^{\circ}\acute{E}\grave{O}\tilde{E}\tilde{A}\grave{e}\grave{O}\tilde{A}\tilde{E}\grave{a}\rangle\tilde{A}\grave{U}\tilde{A}\tilde{O}^1\grave{e}\grave{O}$ $\acute{A}\tilde{A}\tilde{O}\tilde{A}\tilde{E}\tilde{N}_\mu\grave{C}_i\acute{a}\grave{D}\tilde{E}\tilde{O}\grave{e}\S\acute{a}\grave{C}^{\cdot}\tilde{A}\acute{e}\acute{I}\tilde{A}\tilde{A}\grave{C}\tilde{A}\cdot\tilde{N}\acute{e}\S\grave{a}_j^3\pm\grave{I}\tilde{A}\tilde{O}\tilde{m}\tilde{A}^{\circ}\grave{O}^1\grave{m}\grave{C}\grave{O}\tilde{A}\rangle\tilde{A}\acute{I}^{\cdot}\tilde{A}\tilde{N}\tilde{A}\grave{C}_i\S\acute{E}\grave{O}\tilde{E}\tilde{A}\grave{e}\grave{O}\tilde{A}\tilde{E}\grave{a}\rangle\tilde{A}\grave{U}\tilde{A}\tilde{O}^1\grave{e}\grave{O}$

$\acute{a}\rangle\tilde{A}\acute{a}\tilde{D}\grave{a}\tilde{A}\tilde{O}\tilde{A}^{\circ}\grave{a}\tilde{A}\tilde{O}\tilde{A}\S\grave{a}^{\cdot}\tilde{A}\tilde{N}\tilde{m}^1\grave{O}^{\cdot}\grave{a}\tilde{N}\tilde{A}_j\tilde{A}\acute{e}\grave{O}\tilde{E}\grave{O}-,\ ^3\tilde{N}^{\circ}\tilde{A}\grave{O}\tilde{A}\tilde{A}^3_i\ ^a\tilde{O}\tilde{A}\tilde{D}\tilde{E}\tilde{O}\tilde{C}\tilde{A}\tilde{A}^3\acute{a}\tilde{D}\tilde{A}\tilde{E}.\ ^{\circ}\tilde{O}\acute{E}\tilde{A}\grave{O}\ ^{\circ}\tilde{O}^{11}\grave{O}\grave{m}$

ISBN 978-974-456-680-5; 51 $\acute{E}^1\acute{e}\grave{O}$

$\tilde{A}\grave{O}\grave{m}\grave{O}$ 130 $^{\circ}\grave{O}.$

$_j\grave{O}\tilde{A}\tilde{E}\tilde{N}\grave{e}\S\times\times\acute{e}\acute{I}\tilde{A}\tilde{O}\tilde{A}\tilde{D}\grave{a}\acute{I}\tilde{O}\tilde{A}^{\cdot}$

$\frac{1}{4}\tilde{A}\S\grave{O}^1$

$_j\grave{O}\tilde{A}^{\cdot\cdot\cdot}\acute{E}\grave{O}.,\grave{O}^{\circ}\tilde{N}\tilde{m}\tilde{A}$

$^a\times\grave{e}\acute{I}\frac{1}{4}\tilde{A}\S\grave{O}^1:$ $_j\grave{O}\tilde{A}\frac{3}{4}\tilde{N}^{21}\grave{O}_j\tilde{A}\grave{D}^{\circ}\tilde{C}_1;\grave{O}\tilde{A}\tilde{E}\tilde{A}\acute{e}\grave{O}\S_j\tilde{A}^{\cdot}\grave{a}\grave{C}\tilde{A}\tilde{N}^1.\tilde{O}\grave{e}\tilde{A}\tilde{O}\tilde{O}\frac{3}{4}\tilde{N}^1.\grave{D}\grave{m}\grave{U}\grave{e}\tilde{E}\tilde{O}\tilde{A}\frac{3}{4}\tilde{N}^1,\grave{D}\tilde{a}^1\tilde{a}\tilde{A}\grave{a}\tilde{A}_j\tilde{O}\tilde{A},$ gamma-linolenic acid $\tilde{E}\tilde{A}\times\acute{I}$ GLA $\acute{a}\tilde{A}$ $^1\tilde{O}\tilde{C}\grave{m}\tilde{A}\tilde{O}\tilde{a}\acute{I}\grave{a}.\acute{I}\tilde{a}\tilde{A}\tilde{D}\tilde{A}\acute{O}^{\cdot}\tilde{N}^{\circ}_j\tilde{A}^{\cdot}\acute{I}\tilde{D}\tilde{A}\tilde{O}\tilde{a}^1\grave{C}_i\S\tilde{A}\tilde{O}^1\grave{a}^{\cdot}\tilde{A}\tilde{m}\acute{e}\grave{O}$ 6- $\tilde{O}\tilde{a}\tilde{E}.\cdot\grave{U}\grave{a}\tilde{A}\tilde{E}$ (delta 6- desaturase) $\acute{a}\tilde{A}\tilde{D}\tilde{A}\tilde{O}^1\grave{a}^{\cdot}\tilde{A}\tilde{m}\acute{e}\grave{O}$ 12- $\tilde{O}\tilde{a}\tilde{E}.\cdot\grave{U}\grave{a}\tilde{A}\tilde{E}$ (delta (Spirulina platensis) $\tilde{a}^1\grave{a}\langle\tilde{A}\tilde{A}\grave{I}\tilde{A}\tilde{O}\tilde{E}\tilde{m}\rangle$ *Saccharomyces cerevisiae*

$\frac{1}{4}\grave{U}\acute{e}\rangle\tilde{A}\tilde{D}^{\cdot}\tilde{O}\acute{E}^{\circ}\grave{I}:$ $^1\tilde{E}.$ $\frac{3}{4}\tilde{O}\tilde{A}^{\cdot}\grave{O}$ $\frac{3}{4}\tilde{A}\tilde{E}\tilde{A}\tilde{A}\tilde{O}\grave{a}^1\tilde{m}\tilde{A},$ $^1\tilde{E}.$ $\acute{I}\tilde{A}\tilde{O}\tilde{A}^{\cdot}\tilde{O}$ $\tilde{E}\S\tilde{E}\grave{I}.\acute{I}\S,$ $^1\tilde{E}.$ $\tilde{A}\tilde{O}\tilde{C}\tilde{O}^3\tilde{O}$ $\grave{a}_j\tilde{O}^{\cdot}\tilde{A}^{\cdot},\grave{O}\grave{I},$ Ms. Sanjukta Subudhi, $^1\tilde{O}\S$ $\tilde{E}\tilde{O}\tilde{A}\tilde{O}\tilde{A}\tilde{A}^3_i$

$\tilde{A}\times\grave{e}^1\cdot\tilde{a}^1\rangle\tilde{A}\tilde{D}\grave{a}.\tilde{E}\grave{a}.\tilde{A}$ $\grave{a}\tilde{A}\times\grave{e}\acute{I}\tilde{m}\tilde{O}\tilde{A}\tilde{O}\grave{m}\tilde{A}$ 2549

$\frac{1}{4}\tilde{A}\S\grave{O}^1\tilde{C}\grave{O}^{\cdot}\tilde{N}\tilde{A}.\tilde{O}\grave{e}\tilde{m}\tilde{O}\frac{3}{4}\tilde{O}\tilde{A}\frac{3}{4}\grave{I}\tilde{a}^1\tilde{C}\grave{O}\tilde{A}\tilde{E}\tilde{O}\tilde{A}\tilde{a}^1\rangle\tilde{A}\tilde{D}\grave{a}.\tilde{E}$

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Chirasuwan, N., Chaiklahan, R., Ruengjitchatchawalya, M., B. Bunnag and Tanticharoen, M. 2007 “Anti HSV-1 Activity of *Spirulina platensis* Polysaccharide” *Kasetsart J. (Nat. Sci.)* 41: 311-318.

-

Prommeenate, P., Kurdrit, P. Sirijuntarut, M. and Hongsthong, A. 2007 “Expression of Fatty Acid Desaturase Enzymes from *Cyanobacterium Spirulina platensis* in Yeast *Saccharomyces cerevisiae*” *Kasetsart J. (Nat. Sci.)* 41(1): 130-135.

-

Chaiklahan, R., Khonsarn, N., Chirasuwan, N., Ruengjitchatchawalya, M. Bunnag, B. and Tanticharoen, M. 2007 “Response of *Spirulina platensis* C1 to High Temperature and High Light Intensity” *Kasetsart J. (Nat. Sci.)* 41(1):123-129.

Kunsuk, J., Ruengjitchawalaya, M., Chaiklahan, R., Hongsthong, A., Bunnag, B. and Tanticharoen, M. 2004 "Effect of berberine on fatty acid composition in plasma and thylakoid membrane in *Spirulina* sp. Journal of Scientific Research Chulalongkorn University (Section T), 3 (1), 279-286.

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Subudhi, S., Kurdrin, P., Hongsthong, A., Sirijuntarut, M., Cheevadhanarak, S. and Tanticharoen, M. 2008 "Isolation and functional characterization of *Spirulina* D6D gene promoter: Role of a putative GntR transcription factor in transcriptional regulation of D6D gene expression" Biochemical and Biophysical Research Communication, 365:643-649.

Hongsthong, A., Sirijuntarut, M., Prommeenat, P., Thammathorn, S., Bunnag, B., Cheevadhanarak, S. and Tanticharoen, M. 2007 "Revealing differentially expressed proteins in two morphological forms of *Spirulina platensis* by proteomic analysis" Molecular Biotechnology, 36: 123-130.

Kurdrin, P., Subudhi, S., Cheevadhanarak, S., Tanticharoen, M. and Hongsthong, A. 2007 "Effect of two intermediate electron donors, NADPH and FADH₂, on *Spirulina delta* 6-desaturase co-expressed with two different immediate electron donors, cytochrome b5 and ferredoxin, in *Escherichia coli*" Mol. Biol. Rep., 34: 261-266.

Hongsthong A., Subudhi, S., Sirijuntarut, M., Kurdrin, P. and Cheevadhanarak, S. 2006. Revealing the complementation of ferredoxin by cytochrome b5 in *Spirulina delta* 6-desaturation reaction by N-terminal fusion and coexpression of fungal-cytochrome b5 domain and *Spirulina delta* 6-acyl-lipid desaturase. Appl. Microbiol. Biotechnol. 72:1192-1201.

Kurdrin, P., Subudhi, S., Hongsthong, A., Ruengjitchawalaya, M. and Tanticharoen, M. 2005 "Functional expression of *Spirulina delta* 6-desaturase gene in Yeast *Saccharomyces cerevisiae*" Mol. Biol. Reports, 32(4):215-226.

Ruengjitchawalaya, M., Kovacs, L., Mapaisansup, T., Sallai, A., Gombos, Z., Ponglikitmongkol, M. and Tanticharoen, M. 2005 "Higher plant-like fluorescence induction and thermoluminescence characteristics in cyanobacterium, *Spirulina* mutant defective in PQH₂ oxidation by cytb6/f complex" Journal of Plant Physiology, 162: 1123-1132.

-

Hongsthong, A., Subudhi, S., Sirijuntarat, M. and Cheevadhanarak, S. 2004 "Mutation study of conserved amino acid residues of *Spirulina delta* 6-acyl-lipid desaturase showing involvement of histidine 313 in the regioselectivity of the enzyme. *App. Microbiol. Biotechnol.* 66: 74-84.

-

Hongsthong, A., Paithoonrangasrid, K., Phapugrangkul, P., Deshniun, P., Sirijuntarat, M., Subhudhi, S., Cheevadhanarak, S. and Tanticharoen, M. 2004 "The expression of three desaturase genes of *Spirulina platensis* in *Escherichia coli* DH5a—Heterologous expression of *Spirulina*-desaturase genes, *Mol. Biol. Reports.* 31: 177-189.

-

Hongsthong, A., Deshniun, P., Paitoonrangasrid, K., Cheevadhanarak, S. and Tanticharoen, M. 2003. "Differential Responses of Three Acyl-Lipid Desaturases to Immediate Temperature Reduction Occurring in Two Lipid Membranes of *Spirulina platensis* Strain C1" *J. Biosci. Bioeng.* 96(6), 519-524.

-

Hongsthong, A., Deshniun, P., Paitoonrangasrid, K., Phapugrangkul, P., Tanticharoen, M. and Cheevadhanarak, S. "Effect of temperature on the desaturase genes translation in *Spirulina platensis* C1." *Journal of Applied Phycology.* . (Proceeding)

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Ruengjitchatchawalya, M., Chirasuwan, N., Chaiklahan, R., Bunnag, B., Deshniun, P. and Tanticharoen, M. 2002. "Photosynthetic characteristics of a mutant of *Spirulina plantensis*." *Journal of Applied Phycology.* 14: 71-76.

-

Meesapyodsuk, D., Reed, D.W., Cheevadhanarak, S., Deshniun, P. and Covello, P.S. 2001. "Probing the mechanism of a cyanobacterial delta 9 fatty acid desaturase from *Spirulina platensis* C1 (*Arthrospira* sp. PCC9438)" *Comparative Biochemistry and Physiology Part B.* 129: 831-835.

-

Deshniun, P., Paitoonrangasrid, K., Suphatrakul, A., Meesapyodsuk, D., Tanticharoen, M. and Cheevadhanarak, S. 2000 "Temperature-independent and dependent expression of desaturase genes in filamentous cyanobacterium *Spirulina platensis* C1 (*Arthrospira* sp PCC9438)." *FEMS Micro. Lett.* 184:207-213.

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Nomsawai, P., Tandeau. de Marsac, N., Claude Thomas, J., Tanticharoen, M. and Cheevadhanarak, S. 1999 "Light regulation of phycobilisome structure and gene expression in *Spirulina platensis* C1 (*Arthrospira* sp. PCC9438)" *Plant Cell Physiology.* 40(12): 1194-1202.

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Dr. Sanjukta Sabudhi

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·ÕèÍÁÙè

iÅØèÁÇÔ´ÑÂ à·ªª¹aÃÃÕªÕÇÀÒ¾ÈÒËÃèÒÂ

Ê¶Ò°Ñ¹¾Ñ²¹ÒáÅÐ½Ö;Í°ÃÃÃßßÒ¹μé¹áºº

ÁËÒÇÔ·ÂÒÃÑÂà·ªª¹aÃÃÕ¾ÃÐ´ÍÁà;ÅéÒ,¹ºØÃÕ ÇÔ·ÂÒà¢μºÒ§¢Ø¹à·ÕÂ¹

83 ĖÁÙè 8 áŧÇŖ·èÒŧéÒÁ àŧμ°ÒŖŧŧØ¹à·ŦÂ¹ ĵÃØŖà·¾ĭ 10150

â·ÃĖÑ¾·ĭ: 0 2470 7484 áŧĵ«ĭ: 0 2452 3455