Università degli Studi di Verona
Dipartimento di Biotecnologie

# RELAZIONE SCIENTIFICA FINALE

## Assegno di Ricerca (AdR1769/11)

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| *Nome e Cognome del Beneficiario* | Cinzia Formighieri |
| *Titolo del Programma di Ricerca* | Fenotipizzazione e genotipizzazione di ceppi con modificata efficienza nell'uso della luce in Chlamydomonas reinhardtii |
| *Settore Scientifico Disciplinare di riferimento* | BIO/04 FISIOLOGIA VEGETALE |
| *Nome e Cognome del Responsabile Scientifico* | Roberto Bassi |
| *Durata dell'Assegno di Ricerca (da...a...)* | Da 01/01/2012 a 31/12/2012 |
| *Periodo di riferimento della relazione (da...a...)* | Da 01/01/2012 a 04/05/2012 |
| *Note*<br>*(es.: eventuali periodi di sospensione dell'Assegno, etc.)* | Rinuncia all'assegno di ricerca a decorrere dal 04/05/2012 |

**DESCRIZIONE DELL'ATTIVITÀ DI RICERCA** (*presupposti/obbiettivi, metodologie applicate, risultati intermedi e conclusivi, discussione*)

**Background**

Algae are attractive for commercial applications for the possibility to grow them photo-autotrophically in mass culture conditions as cell factories or for the production of biomass and biofuels. However, exploitation of wild type algal strains collected from the environment could be economically unsustainable as farming with ancestral crops. In particular, large light-harvesting antenna systems, an advantage into the wild where light could be limiting and cells grow at low density, are detrimental during mass cultivation leading to light use inefficiency. This is mainly due to (i) saturation of photosynthesis at relatively low light intensities, with dissipation as heat of excess absorbed energy, and (ii) rapid light extinction within the culture because of self-shading. Model-based simulations predict that strains with a reduced absorption cross section could improve high light utilization in mass culture. However, such strains are not encountered in nature but they have to be generated by genetic engineering. Therefore, random insertion mutagenesis and absorption/fluorescence spectroscopy-based screening have been applied in order to isolate for 'pale green' phenotypes in the unicellular green alga Chlamydomonas reinhardtii. Among 3500 mutants, three strains have been isolated to be 'pale green' and the mutated gene responsible for the observed phenotype has been identified in two of them.

**Aim and applied techniques**

Further characterisation of the aforementioned mutants has been performed at both spectroscopy, biochemistry and genetic level. Promising results in terms of growth yield in high light that could be obtained in the laboratory need to be confirmed at a larger scale, where detrimental effects of light use inefficiency and light attenuation are particularly evident. These strains are being tested for growth in different facilities, changing photobioreactor size and geometry.

**Results and Discussion**

Modifications in the light response curve of photosynthesis have been observed in isolated 'pale green' mutants, leading to improved photon conversion efficiency. Higher cell densities have been achieved as compared to wild type both in flask-scale and in photobioreactor. In particular, decrease in the number of photosystems per cell could be an effective complementary strategy as compared to the sole reduction in the antenna size per photosystem to achieve very low levels of chlorophyll content per cell. Once potentialities of mutants with reduced absorption cross section are verified in the model alga Chlamydomonas reinhardtii, analogous phenotypes could be researched in other more productive algal species to be exploited. Random mutagenesis and phenotype screening methodologies are being developed and applied in Roberto Bassi's lab to Chlorella and Nannochloropsis species.

**DESCRIZIONE DELL'ATTIVITÀ DI RICERCA SVOLTA ALL'ESTERO** (*eventuale*)

**RISULTATI DELLA RICERCA** (*pubblicazioni, rapporti, brevetti, etc.*)

**Publications**

1. Formighieri C., Ceol M., Bonente G., Rochaix J.D. and Bassi R. (2012) Retrograde signaling and photoprotection in a *gun4* mutant of *Chlamydomonas reinhardtii*. Molecular Plant.
2. Formighieri C., Franck F. and Bassi R. (2012) Regulation of the pigment optical density of an algal cell: Filling the gap between photosynthetic productivity in the laboratory and in mass culture. J. Biotechnol, doi:10.1016/j.jbiotec.2012.02.021
3. Bonente G., Formighieri C., Mantelli M., Catalanotti C., Giuliano G., Morosinotto T. and Bassi R. (2011) Mutagenesis and phenotypic selection as a strategy toward domestication of *Chlamydomonas reinhardtii* strains for improved performance in photobioreactors. Photosynthesis Research 108:107–120
4. Formighieri C. and Bassi R. (2011) Algae as a "new" biomass resource – Possibilities and Constraints. In: "Encyclopedia of Sustainability Science and Technology (ESST)" Meyers, Robert A. (Ed.) ISBN 978-1-4419-0851-3. Springer Publishing.

**Submitted Manuscripts**

5. Formighieri C., Kuras R. and Bassi R. Biogenesis of photosynthetic complexes in the chloroplast of *Chlamydomonas reinhardtii* requires ARSA5, a homolog of prokaryotic arsenite transporter and eukaryotic TRC40 for guided entry of tail-anchored proteins (submitted to Plant Journal).

*Il Responsabile Scientifico*

*(Firma)*

*L'Assegnista di Ricerca*

*(Firma)*