

Editorial

Current Advances in Algae Biotechnology (Part II)

“*Current Biotechnology*” is now commencing its 5th year. It has grown over the years and become a reputable international journal known for rapidly publishing exciting new researches in the field. The journal owes its success and popularity to contributions of leading experts from around the world.

In 2015, *Current Biotechnology* released a special issue in the field of algae biotechnology. Due to the great interest and positive feedback, we decided to release a second special issue on “Current Advances in Algae Biotechnology”. The idea behind thematic ‘hot topic’ special issues is to generate maximum impact for the published material in a particular subject area of biotechnology.



Armin Hallmann

Algae biotechnology has made major progress during the past 20 years. Algae are already used as bioreactors for producing bioproducts such as pharmaceuticals, nutraceuticals, cosmetics, pigments and other useful chemicals, value-add products, algal-based biomaterials, feed, aquaculture and more. In addition, many efforts are currently being undertaken to make algae competitive for production of bioenergy and biofuels. Some algal-based strategies also meet the requirements for use in biodegradation, bioconversion, bioremediation or other pollution solutions. A powerful driving force in algae biotechnology is the enticing option to use genetically improved organisms. Selectable marker genes, reporter genes, constitutive and switchable promoters, transformation techniques, and other genetic tools and methods are already available for quite a few algae species and this molecular toolbox is becoming increasingly powerful. Moreover, omic’ technologies have been established in some algae species and several genome sequencing projects are completed, in progress or planned. Genetically engineered algae promise a much broader field of application than unmodified organisms or breeds, e.g., through additionally acquired physiological capabilities and new biochemical reactions or even pathways. For some time, light-sensitive proteins from algae are even being used in brain science and they represent a cornerstone in the emerging field of optogenetics: in transgenic animals, these algal ion channels are able to turn individual neurons on and off instantly in a light-dependent manner. In contrast to basic research approaches, applied research frequently takes advantage of mass-culture strategies for algae. Large scale industrial production of bioproducts from genetically engineered, bred or unmodified algae requires state-of-the-art bioprocess engineering, fermentation, harvesting and downstream processing. The first special issue on “Current Advances in Algae Biotechnology” was composed by 15 articles and started with my own, broad overview introducing the theme under the title “Algae Biotechnology – Green Cell-Factories on the Rise” [1].

This second special issue on “Current Advances in Algae Biotechnology” is composed by 7 articles and highlights further, current advances in the field of algae biotechnology.

The special issue starts with a review about molecular tools for bioengineering of microalgae [2]. Kumar *et al.* give an overview about all the methods currently in use or being developed to generate transgenic eukaryotic microalgae and they provide examples. Transgenic microalgae have become indispensable in today’s basic research on algae and there is also a growing interest to use transgenic microalgae for economical production of bioproducts and biofuels.

In the following review, Best *et al.* discuss the use of an emerging technology platform for algal biotechnology, the microdroplet technology [3]. This technology can be used in a variety of applications, including monitoring of growth characteristics at the single-cell level and high-throughput screening of algal populations. The microdroplet technology makes it possible to determine certain characteristics of each cell of a population, and thus to identify

and select the candidate cell with the best characteristics for further propagation and finally for large scale applications.

Yun *et al.* discuss the implementation of ecological principles for sustainable, large-scale production of algal biomass [4]. According to the authors, careful management of food-web structure and algal crop diversity, as well as experiences and insights from modern agriculture can be used to guide the design and operation of industrial-scale algal biomass production systems.

A review by Eustance *et al.* focuses on the use of waste nutrients used for cultivation of microalgae, specifically nutrients that are currently being underutilized or wasted, such as carbon dioxide and ammonia [5]. The authors summarize efforts to quantify and improve carbon dioxide and ammonia utilization in microalgal cultivation and to reduce overall volatilization and loss of these valuable nutrients. They conclude that these volatile nutrients can be effectively utilized for microalgal cultivation.

In a research article, Schramm *et al.* evaluate the impact of the optical properties and respiration of algal cells with truncated antennae on biomass production [6]. The authors come to the conclusion that under natural light conditions, a negative impact of increased respiration and absorptivity of antenna truncated cells has to be taken into account to judge the biomass production potential of antenna truncated alga strains. Alternative approaches to increase biomass productivity of photobioreactors are suggested.

Fernández *et al.* deals with the development of emulsions that have high stability for long-term algal cell storage and that release cells rapidly when applied to a pond surface as inoculum [7]. The authors demonstrate that spray application of a water-in-oil emulsion has the biggest impact on the release rate of microalgae.

Selvakumar and Umadevi analyze mass cultivation of microalgae for bio-fuel production under outdoor conditions [8]. The authors suggest that the coastal area of Visakhapatnam (India) is a feasible location for the production of biomass via large-scale mass culture in an open-air shallow pond.

We hope that you will enjoy this second special issue on “Current Advances in Algae Biotechnology” and that we will encourage you to think about own (further) contributions that you perhaps can make to this exciting field.

REFERENCES

- [1] Hallmann, A. Algae biotechnology – Green cell-factories on the rise. *Curr Biotechnol* 2015; 4(4): 389-415.
- [2] Kumar, A., Perrine, Z., Stroff, C., Postier, B. L., Coury, D. A., Sayre, R. T., Allnutt, F. C. T. Molecular tools for bioengineering eukaryotic microalgae. *Curr Biotechnol* 2016; 5(2): 93-108.
- [3] Best, R., Abalde-Cela, S., Abell, C., Smith, A. G. Applications of microdroplet technology for algal biotechnology. *Curr Biotechnol* 2016; 5(2): 109-17.
- [4] Yun, J.-H., Smith, V. H., La, H.-J., Chang, Y. K. Towards managing food-web structure and algal crop diversity in industrial-scale algal biomass production. *Curr Biotechnol* 2016; 5(2): 118-29.
- [5] Eustance, E., Wray, J. T., Badvipour, S., Sommerfeld, M. R. Volatile nutrients - Improving utilization of ammonia and carbon dioxide in microalgal cultivation: A review. *Curr Biotechnol* 2016; 5(2): 130-41.
- [6] Schramm, A., Jakob, T., Wilhelm, C. The impact of the optical properties and respiration of algal cells with truncated antennae on biomass production under simulated outdoor conditions. *Curr Biotechnol* 2016; 5(2): 142-53.
- [7] Fernández, L., Higgins, B., Scher, H., VanderGheynst, J. S. Spray application and release of microalgae from water-in-oil emulsions. *Curr Biotechnol* 2016; 5(2): 154-62.
- [8] Selvakumar, P., Umadevi, K. Mass cultivation of indian microalgae for bio-fuel production under outdoor conditions of Visakhapatnam India east coast. A review. *Curr Biotechnol* 2016; 5(2): 163-70.

Armin Hallmann
(Guest Editor)

Department of Cellular and Developmental Biology of Plants
University of Bielefeld
Bielefeld
Germany