Development of a fully enzymatic conversion process from marine chitin to chitosan oligomers

Chapter 8

Impact of the research

The novel enzymatic process developed in this thesis for the production of COS from chitin proved to be a viable alternative to current chemical processes when comparing production rates and total conversion yields. Until now, COS are mainly produced from chitin by harsh chemical treatments resulting in less defined products and contaminations by residual chemical reactants. Thus, the implementation of chemically produced COS in medical products is strictly regulated and opportunities for the development of novel products is thereby limited. The novel enzymatic process will eliminate the use of harsh chemicals for decrystallization-, depolymerisation- and deacetylation- reactions and increases biocompatibility and safety of products simultaneously. The novel production process could stimulate the development of novel medical products and applications implementing functional COS molecules with increased biocompatibility. Healthcare sectors and subsequently social fields could further profit from a stronger implementation of COS in medicinal products as novel disease treatments and preventive medication approaches could be developed and explored. As a further consequence, the enzymatic process will support the value chain by creating a new and more direct link between raw material producers (e.g. shrimp industry) and biomedical industries. The implementation of the novel process may be part of the increase in profits for these industries. Future projects could bridge both fields directly by establishing a close cooperation with biomedical R&D institutions for the implementation of COS into novel products. The scope of this project is communicated openly and frequently using multiple channels such as conferences, exhibitions, as well as the press. Thereby, novel contacts from research institutions as well as companies operating at both ends of the value chain were established successfully resulting in novel projects and fruitful cooperations. Currently, the cooperation with partners from chemical industry is being established to explore future applications for enzymatically produced chitosan and COS.

Besides the novel COS production pathway the novel bacterial strain Chi5 as well as the chitinolytic enzymes could help to develop alternative technologies and products that can be used to transit to a more circular and biobased society and minimize the accumulation of chemical waste streams. In a running project, the unique growth characteristics of Chi5 are explored and channelled into a more product-oriented manner e.g. recombinant protein and bioplastic (PHA) production thus further

strengthening the paradigm “from waste-to-product”. Momentarily, feasibility studies are carried out in cooperation with a shrimp processing company and a university of applied science to assess the potential of Chi5 as a novel sustainable and economically attractive PHA production platform. In this context, partners from chemical industries were contacted and currently potential applications for PHA produced by Chi5 are explored. The three expression vectors developed in this project were successfully implemented in additional projects as a cloning and expression platform for recombinant proteins. Chitinases have shown to exhibit antifungal properties by degrading fungal cell walls and currently applications as a biological crop-protection agent are explored together with partners from agrochemical industries. Patent submissions for this application are currently in preparation. Chi5 is currently implemented in an European project aiming for the development of new marine ingredients and products using underutilized marine bioresources such as jellyfish, starfish and invasive crab species as a raw material. In this context the increasing competition for limited natural resources due to the estimated demographic growth is addressed thus the transition to a more biobased society is further stimulated.

Peer-reviewed publications describing the entire process development could further be used to communicate the most essential findings in this thesis to the scientific community potentially stimulating more research in the enzymatic production of COS from marine chitin instead of e.g. harshly chemically pre-treated colloidal chitin or chitosan powder.

In summary, the findings summarized in this thesis will cover a wide spectrum of future applications for enzymatically produced COS as well as the origin bacterium Chi5. The current scientific impact can be determined by the high interest from industry as well as running projects exploring the development of a range of different applications. Future social impact of the research could be evaluated after the implementation of potentially novel biobased products derived from chitin.