Separation and Purification of 1,18-Octadecenedioic Acid

Fraunhofer Institut Umwelt-, Sicherheits-, Energietechnik UMSICHT

H.-J. Körner[1], G. Deerberg
Fraunhofer Institute for Environmental, Safety, and Energy Technology UMSICHT, Osterfelder Strasse 3, 46047 Oberhausen, Germany, Phone[1]: +49 208 8598-1272, E-mail[1]: hans-juergen.koerner@umsicht.fraunhofer.de

Introduction

In the last years biotechnological processes have become increasingly important for the manufacture of chemical products such as special polymers, fine chemicals and pharmaceuticals. Therefore, in the mid of 2005, eight Fraunhofer Institutes joined to form a research alliance[1]. The research activities are geared towards developing and establishing a technology platform for the integrated manufacture of bio-based chemical products using biotechnological processes, with optimum utilization of natural synthesis. Plant oils and fats are being used as model systems. As an example, the components of the fats (fatty acids/monocarboxylic acids) are transformed by biotechnological means into α, ω-dicarboxylic acids (1,18-octadecenedioic acid). These chemicals are then converted into polymeric products.

Objectives

The success of biotechnological processes is determined by the chosen bioconversion step as well as by the processes for product isolation and purification. Following the bioconversion, the raw product mixtures typically only contain low concentrations of the desired product. At the same time, there are high requirements on the purity of the final product. These conditions place high demands on the selection and the optimal setup of the necessary separation and purification technology. The main objective is to recover the product from the fermentation broth taking into consideration the given specifications and economic aspects. Basically, the downstream-processing can be devided into four major steps:

- removal of insolubles,
- product isolation,
- product purification and
- product polishing.

For these steps, there are a couple of different physicochemical unit operations available, which have to be investigated and evaluated within the project.

Downstream Processing

After investigation and evaluation of different recovery methods, the selected unit operations are brought together to an overall downstream process. (figure 1).

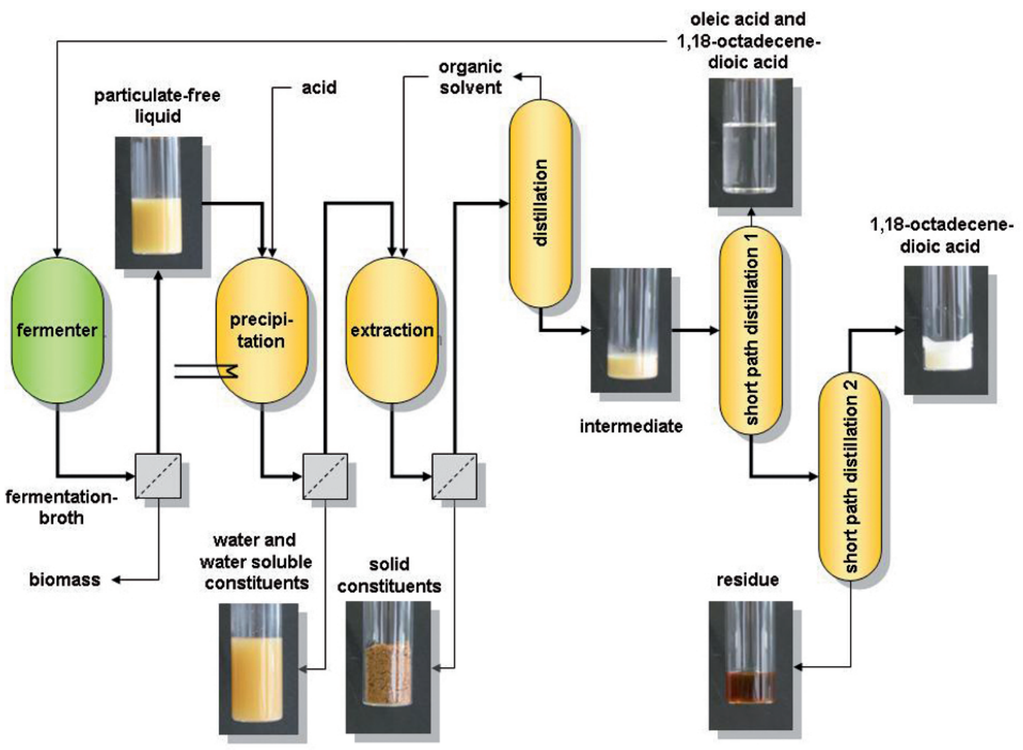

Fig.1: Downstream processing of 1,18-octadecenedioic acid

The first step of the downstream processing is the removal of the biomass and involves the capture of the product as a solute in a particulate-free liquid by centrifugation. Water is the chief impurity in the production of 1,18-octadecenedioic acid. In order to reduce the volume of material to be handled and to concentrate the product, our experiments showed that precipitation is an appropriate unit operation. After this, oleic acid and 1,18-octadecenedioic acid can be separated from further impurities by solvent extraction in combination with a filtration step. The recovery of the organic solvent can be realized by distillation. In a two-stage short path distillator, the final product purification is done to separate those contaminants that resemble the product very closely in physical and chemical properties. Finally, oleic acid can be removed as the low boiling fraction in the first stage and in the second stage further impurities can be removed as the high boiling fraction.

For the evaluation of the developed downstream processing the considerable criteria are the achievable product cocentration (purity) and the product loss (figure 2).

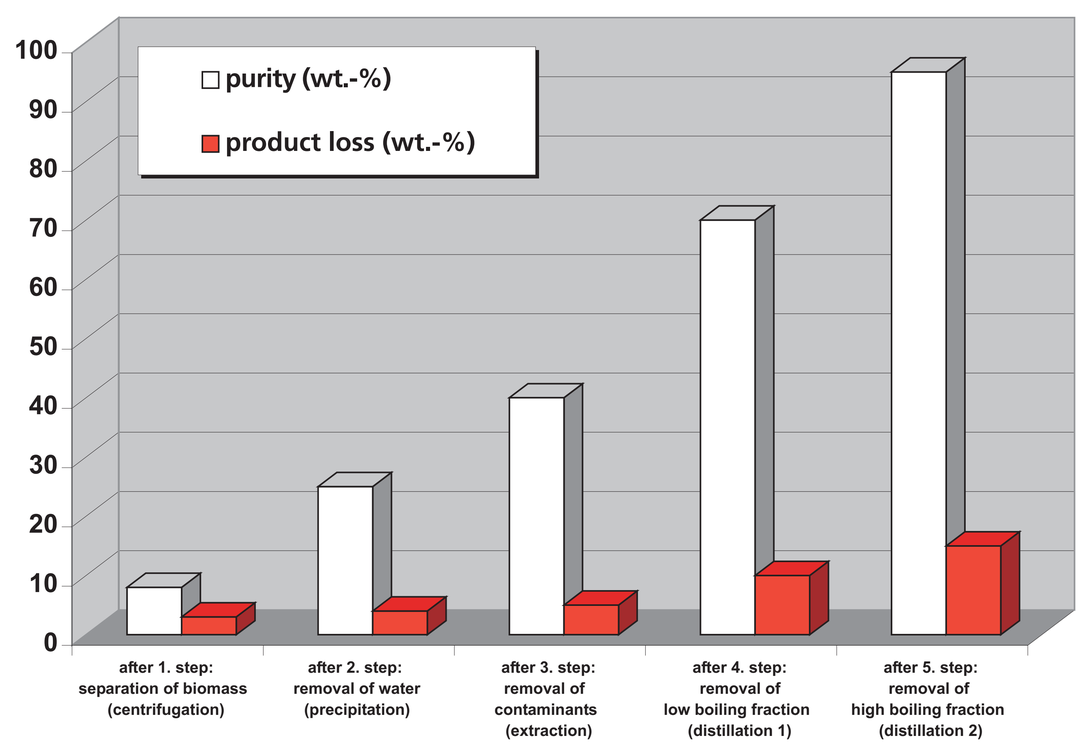

Fig.2: Purity and product loss

Summary

In conclusion, it can be said that for the separation and purification of 1,18-octadecenedioic acid the appropriate downstream processing was developed taking into consideration the given boundary conditions. For this, different unit operations were investigated and evaluated.

The investigations showed that:

- biomass and water can be removed cost-effectively by centrifugation and precipitation,
- the separation of impurities can be achieved by solvent extraction,
- the short path distiller is an appropriate unit operation for the final product purification,
- the achieved purity of 1,18-octadecendiocic acid is higher than 95 wt.-%,
- the product loss is lower than 15 wt.-% and
- most of this product loss can be recirculated.

1 Fraunhofer Institutes of the research alliance "BioProChem": IAP, ICT, IGB, IME, IPA, UMSICHT, IVV and WKI