

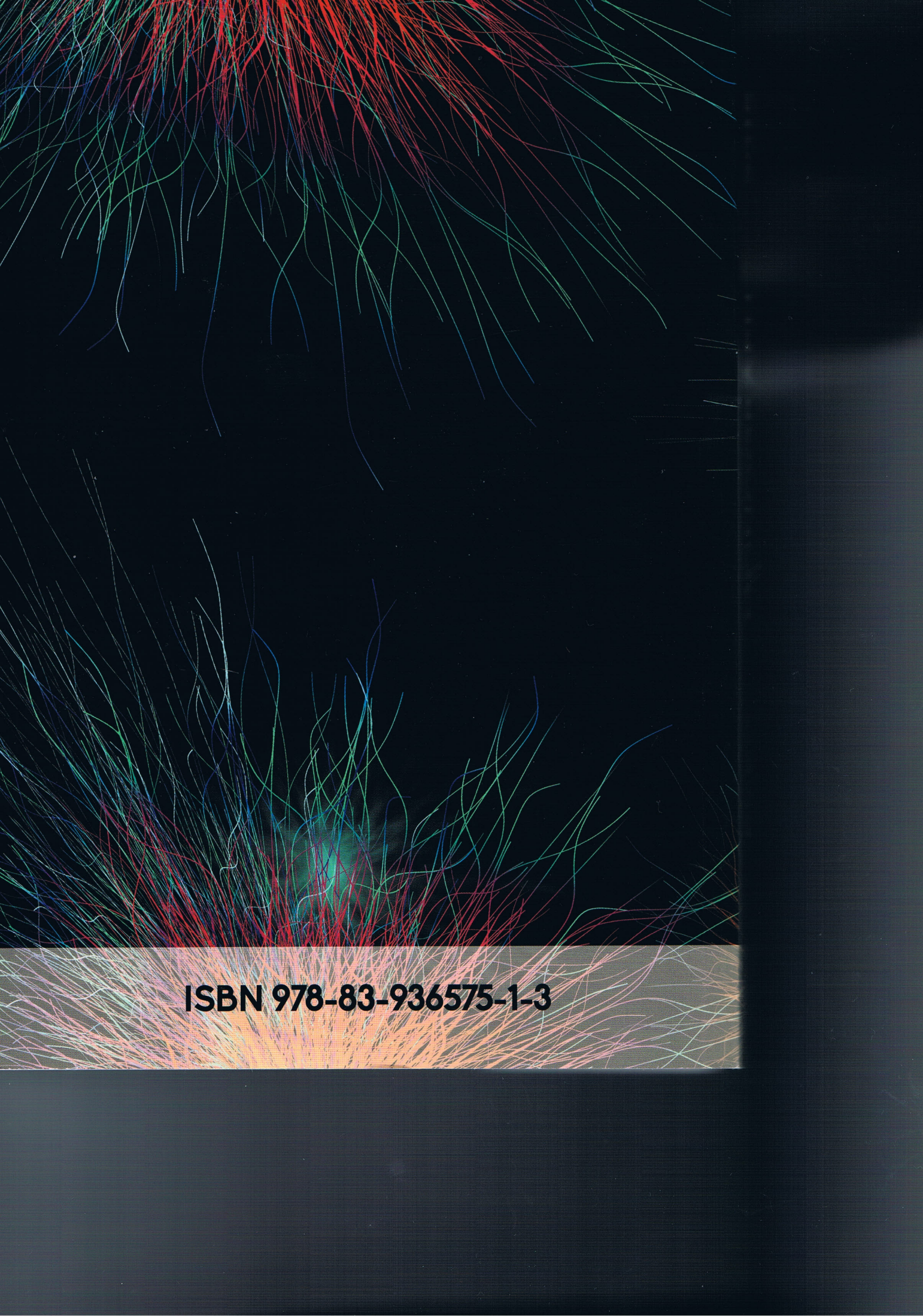
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The background of the entire page is a black field filled with a dense, chaotic network of thin, fiber-like lines. These lines are primarily red, green, and blue, with some yellow and orange lines visible at the bottom. The lines appear to be radiating from the bottom edge, creating a sense of depth and movement. The overall effect is reminiscent of a microscopic view of a material or a complex network of data.

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Application of UV spectrophotometry in the quality control of galactooligosaccharides production

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Keywords: galactooligosaccharides, online monitoring, UV spectrophotometry, partial least square regression, prebiotics, chemical analytics, chemical quality control

ABSTRACT

Galactooligosaccharides (GOS), hence they have a positive effect on the microbial composition of the gut, are considered as prebiotics. From this substrate, GOS are produced by enzymatic synthesis with β -galactosidase. In the industrial practice of GOS production, batch reactors are widely used in order to make the process more effective and to reduce the costs. Other configurations, like enzyme membrane reactors or immobilized enzymes operating in continuous fashion, can be considered. The implementation of these processes requires the online monitoring of the quality of the product. The enzymatic reaction results in a saccharide mixture consisting of reacting lactose, GOS of various degree of polymerization, and glucose. The product is a mixture of these components. The standard chemical analysis of such multi-component mixture involves High Performance Liquid Chromatography (HPLC). Although HPLC is reliable and accurate, it is generally considered as a time-consuming and offline method.

This research deals with the development of an online technique that enables real-time monitoring of carbohydrate composition during the production of GOS. For that purpose, we considered ultraviolet-visible spectrophotometry combined with partial least squares regression (PLSR). Eighty-one samples, containing various amounts of mono- and oligosaccharides, were generated in our lab by using an enzymatic reactor. UV spectral data of the samples were used together with the concentration data quantified by HPLC, in order to develop a PLSR model. The results show that UV spectral data combined with PLSR data processing can be used in quality control of continuous GOS production.

INTRODUCTION

Galactooligosaccharides (GOS) are produced by the enzymatic activity of β -galactosidase, generally described by the formula $\text{Gal}_n\text{-Glu}$, where n is the number of galactose units. They are synthesized from lactose by the enzymatic activity of β -galactosidase. The enzyme is capable to hydrolyze the substrate to glucose and galactose, which increases sweetness and lowers lactose level, which is suitable for infant consumers. The competing transgalactosylation reaction results in the formation of GOS, oligosaccharides of various degrees of polymerization (DP) [4].

In industrial practice, GOS is produced in stirred-tank reactors operating in batch mode. The enzymatic catalysis takes place in a reactor using soluble β -galactosidase. The reaction results in a saccharide mixture consisting of non-reacting lactose, GOS of various degrees of polymerization (typically DP3-DP6), and glucose. After the catalytic performance the solution is heated up to inactivate the enzyme. This is a simple and easily controlled process.

There are alternative routes to overcome some of the drawbacks of batch production in conventional batch reactors. Using enzymatic catalysis in membrane reactors or immobilized packed-bed reactors enables us to achieve higher conversion rates and results in an enzyme-free product [5]. Although these processes are more effective and reduce costs, the implementation of such processes requires the online monitoring of the quality of the product.

Online monitoring of carbohydrate composition during the production of GOS. For that purpose, we considered ultraviolet-visible spectrophotometry combined with partial least squares regression (PLSR). Eighty-one samples, containing various amounts of mono- and oligosaccharides, were generated in our lab by using an enzymatic reactor. UV spectral data of the samples were used together with the concentration data quantified by HPLC, in order to develop a PLSR model. The results show that UV spectral data combined with PLSR data processing can be used in quality control of continuous GOS production.

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