Application of Bacterial Cell Principal Component IRQuantitative Analysis for Fermentation Process Monitoring

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In biotechnology IR spectroscopy is an established time-saving method to monitor dynamics of chemical and biological processes and is capable to detect small molecular absorbance changes against a large background absorption. The macromolecular composition of microorganism biomass is an integrated and quite variable indication of the organism physiological state, reflecting the influence of cultivation conditions on cell regulatory mechanisms.

This study presents *Clostridium acetobutylicum* acetone-butanol-ethanol (ABE) fermentation process monitoring by IR-spectroscopy, detecting quantitative changes of the principal cell components under different fermentation conditions and shedding some light on the connection between the cell physiological state and solvent production peculiarities. The ABE fermentation is characterised by several distinct phases of different product formation, accompanied by morphological changes in the cells.

The concentrations of carbohydrates, nucleic acids, proteins and lipids in *C. acetobutylicum* cells during fermentation were evaluated from the mid-IR absorption spectra [1]. *C. acetobutylicum* biomass spectra were also recorded in the FT-IR technique as dried films on ZeSe crystals, on a Bruker IFS 28B spectrometer at a resolution of 6 cm^{-1} [2].

Quantitative IR analysis of *C. acetobutylicum* biomass during ABE fermentation under different aeration conditions of vegetative or spore inoculum, showed marked changes in lipid and nucleic acid content over the growth and production phases of the organism. The content of nucleic acids decreased with process time, and the lipid content increased, corresponding to ceasing growth and formation of the toxic fermentation products. The physiological states of either solvent production or acid crash were reflected in the microbial biomass composition, which can be assessed by IR-spectroscopy. Carbohydrate and protein content changes during the growth were less pronounced. It is demonstrated that the concentrations of the principal cell components correlate with the cell physiological state.

The statistical spectrum analysis can tell the physiological status of a biomass sample, and IR-spectroscopy methods can be applied for ABE fermentation monitoring and concrete product over-production planing.

References

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