113 **CELL MASS AND PHYCOCYANIN PRODUCTIONS BY *Spirulina platensis* IN AN OPTICAL FIBER INSTALLED FERMENTOR.**

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Spirulina platensis cells contain a high amount of phycocyanin (10 to 20 %), an important blue pigment used in food industries. Frequently light supply becomes a limitant in the cultivation of *Spirulina*, and it is difficult to cultivate the algae at high cell density. If optical fiber light is applied for photosynthetic cultivation, dense culture with a high productivity of cell mass may be obtained. In this study, batch and continuous cultures were carried out to investigate growth yield, cell mass productivity, and phycocyanin content in the cell under optical fiber light as irradiance source.

Spirulina platensis NIES-39 was used and grown in a SOT medium (1). For batch culture, 1.0 liter Roux bottle containing 500 ml of medium was used under 2-8 klux of tungsten lamps for 7 days at 30° C. Continuous culture was carried out in a 2.0 liter Fermentor (medium: 990 ml) at 300 rpm agitation. Irradiation was provided by optical fibers (Moritex, model MHF-100 L, halogen lamp) in the range of 1 to 24 klux while the temperature was fixed at 30° C, and dilution rates were 0.01 - 0.035 h^{-1}.

In batch culture, the maximum growth rate of 0.063 h^{-1} was obtained at 30° C at 8 klux. In continuous cultures, maximum cell conconcentration was 0.305 g / *l* at a dilution rate of 0.023 h^{-1} when 2.8 x 10^{-2} kJ cm^{-2} h^{-1} of light energy was supplied, while phycocyanin content (0.15 g / g cell max.) decreased when light energy was increased. The growth yield, 2.4 x 10^{-2} g / kJ was comparable with the previous data (2).

References

1. Ogawa, T., and Terui, G. (1970). J. Ferment. Technol., 48, 361-367.
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114 **Fuzzy Control of Fed-Batch Fermentation with the Aid of Neural Networks**

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It is of practical importance to consider the effective feeding strategy for the fed-batch fermentation. However, the control system design is not straightforward due to the inherent nonlinear and time-varying characteristics. Note that the controller gain must be changed as time proceeds in accordance with the increase of the cell concentration to maintain good control performance.

Since it is fairly difficult to describe exactly the dynamic behavior of microorganisms by means of mathematical expression in many cases, it is desired that the method be developed without using exact mathematical models. The Fuzzy control system makes use of the information obtainable from operator's intuitions and experiences, and puts the empirical rules into linguistic description.

Here we consider the fed-batch baker's yeast fermentation, where the mesurement variables are DO and ethanol concentrations, and the input variable is the feeding rate of glucose. The feeding rate was determined based on the standard IF-THEN rules using fuzzy variables, and yet with the aide of Neural Networks, where the Neural Networks were employed to recognize the patterns of the change in the measurement variables which are used to modify the feeding rate.

The structure of the Neural Network consists of three layered neurons,where the numbers of neurons for input, hidden, and output layers are 70, 4, 2 for DO concentration and 250, 4, 3 for ethanol concentration, respectively. The weights of the networks were determined using the delta rule for the back propagation developed by Rumelhart with randomly generated training data of 500 for DO and 1500 for ethanol. The learning procedure was terminated after 1500 of iterations.

It was shown that the performance of the proposed method is much better than that attainable by the Fuzzy control without using Neural Networks.