Korean J. Appl. Microbiol. Bioeng.
Vol. 7, No. 1, 47~48(1979).

—Short Communication—

Increasing the Cell Density in SCP Production from Cellulosic Substrtaes

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(Received Jan. 25, 1979)

섬유질기질로부터 SCP생산에 있어서 균체농도증가

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(1979년 1월 25일 접수)

Abstract

Undigested cellulosic substrate was frequently replaced with new substrate during fermentation. About 3-fold increase in cell density could be obtained by changing the substrate.

Cellulosic crop resiue is the major agricultural waste and has not been effectively utilized. Because of the need for waste utilization and pollution abatement, considerable efforts have been made to utilize these materials. Attempts to produce single-cell-protein from cellulosic crop residues are example (Han, et al; Bellamy, 1975; Thayer et al, 1975). However, unfavorable economic factor made these processes impractical. Low cell yield is cited to be the single most important economic factor in SCP production from cellulosic substrate (Dunlap, 1975). Because cellulose is rather recalcitrant substrate, cell growth on this substrate is slow. The productivity, in terms of cell mass per unit fermentor volume per unit time, is extremely low in cellulose fermentation compared to such processes as growth of organisms on molasses or starch.

Agricultural crop residue, such as rice straw, contains about 50% cellulose and hemicellulose and the rest consists of lignin, silica, and ash. Of the 50% cellulose and hemicellulose, about half is considered to be crystalline and the other half amorphous region. The crystalline region is hard to be degraded by chemicals and microbial enzymes. The crystalline may be converted to amorphism by chemicals such as NaOH.

Thus, without proper chemical treatment only about 25% of the straw is readily digested and the rest simply remains in the fermentor as a bulk which hinders the formation of enzyme-substrate complex and supply of O_2 and nutrients.

In an effort to increase the cell density in cellulose fermentation, we have frequently removed the undigested substrate and replenished with new straw. By replacing the undigested straw with new straw in every 48 hr a curve similar to a typical diauxic growth curve (Fig. 1) was obtained. Cell density increased drastically as undigested substrate was replaced with new substrate, and about 3-fold increase in final cell density was obtained compared

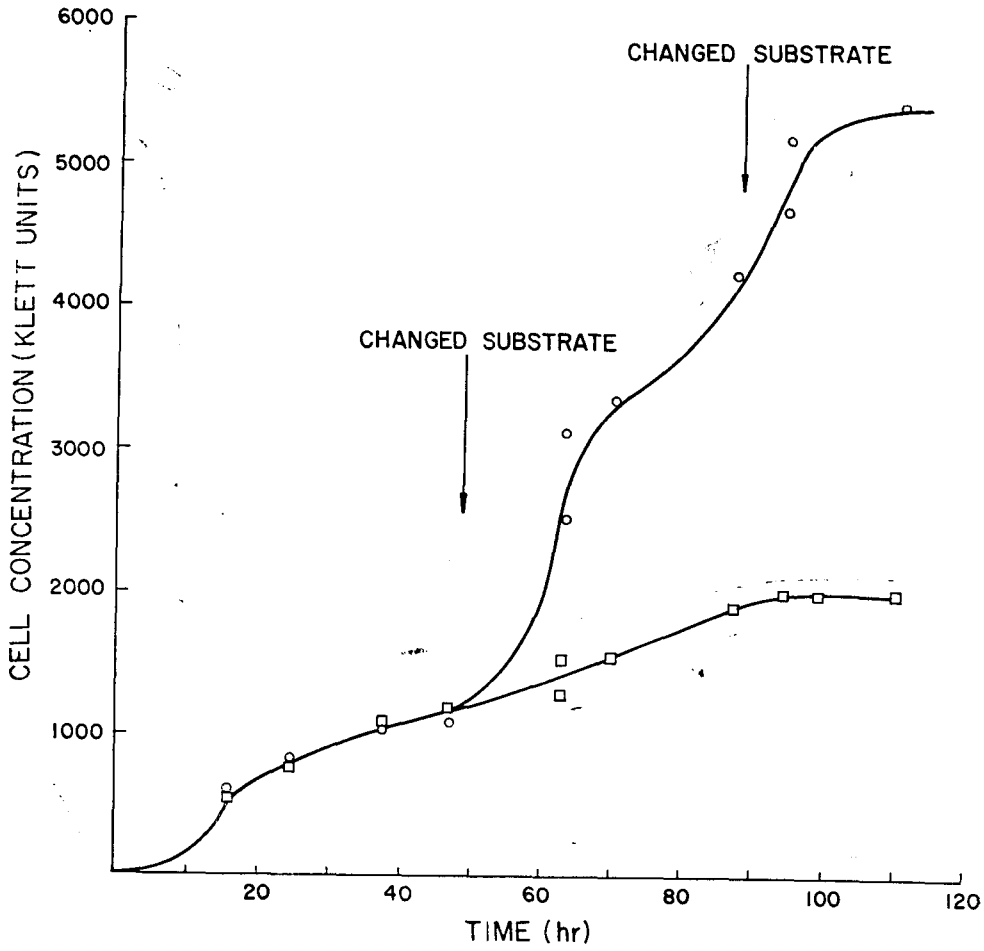

Fig. 1. Kinetics of Cell Growth: Mixed culture of *C. flavigena* and *A. faecalis* were grown in basal mineral solution containing 2.8% of NaOH-treated straw. Undigested straw was filtered out with cheese cloth at every 48 hr. Fermentation was carried out in duplicated 14-1 fermentor (New Brunswick) at 35°C. Oxygen absorption rate of the fermentor was 0.216 $mMO_2/1/min$.

to that of batch culture where substrate was unchanged throughout the 120 hr fermentation period. This is due to the fact that readily utilizable substrate was available for microbial growth by replacing the substrate. Therefore, the low cell density frequently observed in cellulose fermentation is mainly due to lack of rapidly metabolizable energy source.

Table 1 also shows the level of cell growth in flasks that contained different kind of straw. During the 4 day fermentation, about 2400 Klett unit of cell growth was observed on 2% NaOH treated straw. However, when the undigested straw was replaced with new straw the cell yield was almost doubled. The cell growth was extremely poor on the undigested straw, yielding only half that produced on 2% NaOH treated straw. Because of the insoluble nature of cellulose, it is difficult to load sufficient amount (for example, more than 5%) of cellulosic substrate in submerged fermentation. This problem may be solved by (1) proper chemical and physical treatments to make the substrate more easily digestible, (2) application of a process such as semisolid fermentation process (Han

Table. 1. Level of Cell Growth on Different Kind of Straw

Substrate	Cell growth (Klett unit)
NaOH-treated straw[a]	2,400
Undigested straw replaced[b]	4,100
Undigested straw[c]	1,200

a. A mixed culture of *Cellulomonas flavigena* and *Alcaligenes faecalis* was grown on 2% NaOH treated straw for 4 days in a shake flask.
b. Undigested straw was replaced with fresh NaOH treated straw every 24 hr.
c. A mixed culture of *C. flavigena* and *A. faecalis* was grown on the removed undigested straw.

and Anderson, 1975), where large quantity (up to 25%) of substrate can be used, and (3) developing a method in which undigested substrate are frequently replaced with fresh substrate during fermentation.

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