REFERENCES

ช่อทิพย์ หล่อรุ่งเรือง "การเพิ่มโปรตีนในมันสำปะหลังโดยวิธี Symba yeast เพื่อใช้เป็นอาหารสัตว์" วิทยานิพนธ์ปริญญาโทมหาวิทยาลัยเกษตรศาสตร์ 2529

ดวงดาว กัษณหะสิริ "การหาปัจจัยประกอบเพื่อการผลิต Symba Yeast" วิทยานิพนธ์ ปริญญาตรี สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง 2533

จรูญ วันทนาลักขณา สถิติ วิธีวิเคราะห์และวางแผนงานวิจัย 2535

รุ่งโรจน์ มธุรพร " การเพิ่มโปรตีน ในมันสำปะหลังโดยการหมัก " วารสารวิทยาศาสตร์การอาหาร 12 (1) 2523

วิชชุพร ว่องสุวรรณเลิศ " จุลินทรีย์โปรตีนกากมันสำปะหลังโดย Rhizopus และยีสต์ " วิทยานิพนธ์ปริญญาโท มหาวิทยาลัยเกษตรศาสตร์ 2529.

Burrows, S., Baker's yeast. In: Rose AH (ed) Microbial biomass. Academic Press, London, p. 332-64, 1979.

Dostalek, M.,Haggstrom,M.H., "Mixed culture of S. fibuliger and Zymomonas mobilis on starch Use of Oxygen as Regulator. "Eur J Microbiol Biotechnol, vol 17, p. 269-274, 1983.

Dostalek, M., "Production of lipid from starch by a nitrogen-controlled mixed culture of S. fibuligera and Rhodosporidium toruloides. "Appl Microbiol Biotechnol, vol 24, p. 19-23, 1986.

Endang, S., and Horst, W., "A one step process for the production of protein and amyloglucosidase "Appl Micro. Biotechno, vol 30, p. 135-140, 1989.

Fiechter,A., Fuhrmenn, G.F., and Kaprlli, O., "Regulation of glucose metabolism in growing yeast cells. "Advances in Microbial Physiology, vol 22, p. 123-183, 1981.

Fuhrmann, G.F., and Rothstein, A., "The transport of Zn and Co and Ni into yeast cells ". Biochimica et Biophysica Acta vol 163, p. 325-330, 1968.

Jarl, K., " Symba yeast process " Food Technol, vol 23, p. 1009-1012, 1969.

Jiraporn,S., Kanji K., and Tokuya H., "Glucoamylase of a Strain of E. fibuligera Isolated from Mould Bran (Look Pang) of Thailand." J. Ferment. Technol. Vol.53, No.8, p.559-565, 1975.

Justin,O. N., "Fermentation Process Development of Industrial Organisms" p. 279 , New York, 1989.

Kanji, K., Kapti, K. and. Isao, B., "Identification of E. fibuligera isolated from Ragi in Indonesia and Properties of its Crystalline Glucoamylase." J. Ferment. Technol. Vol. 54, No.12, p. 831-837, 1976.

Lemmel, S.A.,Heimsch, R.C., and Edwards, L.L., "Optimizing the continuous production of Candida utilis and S. fibuligera on potato processing wastewater. " Appl. Env. Microbiol., vol 37, p. 227-232, 1979.

Lindner, P., E. fibuligera. sp., ein neuer Garungspilz und Drzeugerder sog. Kreidekrankheit des Brotes. Wochschr. Brau. vol 24, p. 469-474,1907.

Lodder, J., The yeast, a Taxonomy study. North Holland publishing Co., Amsterdam. p 1385, 1970.

Lowry, O.H., Rosebrough, M.J., and Randall, R.J., J.Biol. Chem, 193-265, 1951.

Lynferd,J. W., Lewis B. L., "Starch hydrolysis and fermentation by the yeast Endomycopsis fibuligera "J. Bacteriol, vol. 48, p. 413-427, 1944.

Nelson, N., " A photometric adaptation of the Somogyi method for the determination of glucose. "J. Biol Chem vol 153, p. 375-380, 1944.

Matsumura, M., Umemoto, K., "Application of use oxygen in a new gas entraining fermentor " J.Ferment Technology, vol 60, p. 565-578, 1982.

Maw, G. A., "Utilization of sulphur compounds by brewers yeast." Journal of the Institute of Brewing, vol 66, p. 162-167, 1960.

Onra, E., "Effect of aeration intensity on the biochemical compposition of bakers yeast. " Biotecnology and Bioengineering, vol 16, p. 1197-1212, 1974.

Pena, A., " The transport of cations in yeasts; characteristics and postulated mechanisms." In Advances in biotechnology current developments in yeast research, Toronto: Pergamon Press, p. 395- 410, 1981.

Peppler, H.J., Yeast technology. in: Peppler, H.J., (ed) Microbial technology. Reinhold New York, p. 145-171, 1967.

Reed, G.,"Production of baker's yeast." In Prescott and Dunn's Ind. Microbiology, 4th ed., G. Reed(ed). AVI Publishing Companu, Westport, Conn. 1982

Shay, L.K., Hunt, H.R., "High-productivity fermentation process for cultivating industrial microorganisms" J. Ind Microbiol, vol 2, p. 79-85. 1985

Stryer, L., Biochemitry, San Fransico : W.H. Freeman, 1981.

Trivedi, N.B., Jacobson G.K., Tesch, W., " Baker's yeast ", Rev. Biotechnology, vol 4, p. 75-109, 1986.

APPENDIX

APPENDIX 1

1. Protein Determination by Lowry method

1.1. Reagents

Alkaline Copper reagent:

A. Solution of 5 % Na_2CO_3 in distillation water.

B.Dissolve 0.5 g of $CuSO_4.5H_2O$ in 100 ml of distillation water.

C. Aqueous solution. of sodium potassium tartrate 2 %

- Just before use, mix 50 ml of A, 1 ml of B and 1ml of C. Discard after 1 day.

Folin reagent:

- Concentrated Folin-Ciocalteau reagent can be purchased commercially from SIGMA Chemical company and is diluted 1:1 with water.

(CAUTION : This reagent contains a strong volatile acid and should not be pipetted by mouth.)

- Solution of 1N NaOH

1.2. Procedure.

Sample 0.5 ml

↓

add 0.5 ml of 1N NaOH

↓

Heat the suspensions at 100°C for 5 min.

and cool in water

↓

add 2.5 ml of Copper reagent

stand for 10 min.

↓

add 0.5 ml of Folin reagent and mix thoroughly

stand for at 30 min.

↓

measure optically density (OD) at wave length 750 nm

in spectrophotometer 21

Standard protein solution: Crystalline bovine serum albumin is use for standard protein solution and linear standard curves. The stock standard solution should contain 0.2 mg of protein per ml in distilled water. Different proteins give different standard curves. The protein standard used should be specified when the results are reported.

2. Determination of sugars by Somogyi and Nelson method

2.1. Reagents

Somogyi reagent

Copper reagent A

Dissolve the following chemicals :

- Na_2CO_3	12.5 g
- $C_4H_4Na_2O_8.4H_2O$	12.5 g
- $NaHCO_3$	10 g
- Na_2SO_4	100 g

in 500 ml of distillated water.

Copper reagent B

Dissolve the following chemicals :

- $CuSO_4.5H_2O$	15 g
- H_2SO_4 Conc.	1-2 drop

in 100 ml of distillated water.

- Just before use, mix 25 ml of A, 1 ml of B. Discard after 1 day.

Nelson reagent

Dissolve the following chemicals :

- $(NH_4)_6Mo_7O_{24}.4H_2O$	12.5 g
- H_2SO_4 Conc.	10.5 ml
- Na_2HAsO_4	1.5 g

in 250 ml of distillated water. Keep at 37°C for 48 hour and should appear yellow color.

2.2. Procedure.

0.5 ml of sample solution

↓

add 0.5 ml of Somogyi reagent

↓

Heat at 100°C for 20 min. and cool in water

↓

add 0.5 ml of Nelson reagent

↓

add distillated water 8.5 ml

↓

measure optically density (OD) at wave length 520 nm in spectrophotometer 21

Standard glucose solution : pure glucose is used for standard protein solution and linear standard curves. The stock standard solution should contain 0.2 mg of glucose per ml in distilled water. Different glucose give different standard curves. The glucose standard used should be specified when the results are reported.

3. Determination of dry weight

3.1. Procedure

10 ml of sample solution

↓

centrifuge at 5000 rpm for 10 min

↓

wash cell twice by distillated water

↓

centrifuge

↓

dry biomass cell at 105° C for 12 hour

↓

weigh

4. Determination of starch in cassava chip :

4.1 Acid hydrolysis of carbohydrate (glucose car.)

1 g of sample into flask of 100 ml

(flask had a tube of glass for condensation)

↓

add 10 ml of 25 % HCL

↓

heat at 100°C in water bath for 3 h.

↓

cool to 30°C

↓

neutralize with 40 % NaOH

↓

dilute with distillated water to have glucose 5-100 ug/ml

↓

Determination of glucose car. by method of Somogyi and Nelson

4.2 Acid hydrolysis of reducing sugar (glucose red.)

1 g of sample into flask of 100 ml

(flask had a tube of glass for condensation)

↓

add 40 ml 0.1 % HCL

↓

heat at 100°C in water bath for 30 min

↓

cool to 30°C

↓

neutralize with 1 N. NaOH to pH 5.0

↓

dilute with distillated water to have glucose 5-100 ug/ml

↓

Determination of glucose red. by method of Somogyi and Nelson

4.3 Calculation of starch

Starch = (glucose car. - glucose red.) x 0.9

APPNDIX 2

4.1 Calculation of the Reynolds Number (Re)

$$Re = (\rho N D^2)/\mu$$

ρ = density of broth 3.5 % of sucrose at 30°C 1.077 g/cm^3

μ = viscosity of broth 3.5 % of sucrose at pH 4-6, 30 °C

$(4 \times 10^{-2}$ g/cm.sec)

N = agitator speed 140 rpm or min^{-1}

D = impeller diameter 20 cm

$$Re = \frac{(1.077 \text{ g/cm}) \times (140 \text{ min}^{-1}) \times (20 \text{ cm})^2}{(4 \times 10^{-2} \text{ g/cm.sec}) \times (60 \text{ sec/min.})}$$

$$= 25130$$

4.2 Calculation of kinetics parameter for C. utilis

U_{max} : the maximum specific growth rate

$$U_{max} = \frac{\ln(x_2) - \ln(x_1)}{t_2 - t_1} = \frac{1.29 - 0.29}{21 - 9} = 0.083 \text{ h}^{-1}$$

$Y_{x/s}$: the biomass yield

$$Y_{x/s} = \frac{mx}{ms} = \frac{4.55 - 1.6}{7.15 - 1.2} = 0.495 \text{ g/g}$$

q_s : The specific biomass production rate

$$q_s = \frac{U_{max}}{Y_{x/s}} = \frac{0.083}{0.495} = 0.167 \text{ g/g.h}$$

$Y_{\%}$: the percent of theriocal biomass yield

$$Y_{\%} = \frac{Y_{x/s}}{0.51} \times 100\ \% = \frac{0.459}{0.51} \times 100\ \% = 97\ \%$$

4. 3 Calculation of kinetics parameter for E. fibuligera 5097

U_{mx}: the maximum specific growth rate

$$U_{max} = \frac{\ln(x_2) - \ln(x_1)}{t_2 - t_1} = \frac{1.29 - 0.29}{21 - 9} = 0.082\ h^{-1}$$

$Y_{x/s}$: the biomass yield

$$Y_{x/s} = \frac{mx}{ms} = \frac{4.8 - 2.2}{6.7 - 1.3} = 0.473\ g/g$$

qs : The specific biomass production rate

$$qs = \frac{Umax\text{-}1}{Yx/s} = \frac{0.082}{0.473} = 0.173\ g/g.h$$

Protein Y% : the percent of theriocal biomass yield

$$\text{protein } Y\% = \frac{Yx/s}{0.51} \times 100\ \% = \frac{0.473}{0.51} \times 100\ \% = 92.7\ \%$$

VITA

Mr. Le Hoang Trien, code C427009 was born in Hanoi Province. He graduated with a Bachelor degree in Chemical Engineering from Faculty of chemical Engineering, Havana University, Republic of Cuba in 1974. He worked as a lecturer at Can tho University, Vietnam until 1989. He continued study in Master degree at Biotechnology Program from Faculty of Science, Chulalongkorn University, Thailand in 1990.