MATHEMATICAL MODELS OF THE DYNAMICS OF FERMENTATION OF WINE YEASTS UNDER THE INFLUENCE OF VITAMINS

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ABSTRACT

Biomass accumulation in yeast has been studied in this work in terms of their role in fermentation processes. So, biotin is involved in many reactions and nitrogen metabolism disorders, in protein biosynthesis and fatty acid synthesis. It is known that yeast cell is not capable to synthesize biotin, but it presence in the environment is unconditionally linked to production cost. Requirement for biotin yeast partially reduced in the presence of amino dicarboxylic environment. Effectiveness is increased under conditions of intense aeration, ascertaining the best results when additives order thousandths per liter of fermentation under anaerobic conditions (Banu, 2008, 2009).

Inositol (vitamin B9) is a derivative of cyclohexane polyol, which participate in lipid synthesis and especially phosphoglycerides.

Comparative studies have demonstrated their good role in fermentation processes and in particular to obtain yeast biomass with higher quality biotech.

KEYWORD

Yeast – inositol -*Saccharomyces bayanus* – biomass – fermentation - bioreactor

INTRODUCTION

Wine yeast strains *Saccharomyces bayanus* have important applications in food industry and in this sense the purpose of obtaining pure cultures and selecting those strains that the laboratory investigations exhibit superior biotechnology. This study was intended: the evolution and development of selected yeast *Saccharomyces bayanus* in culture medium malt mash enriched with biotin, thiamine, inositol, fermentation rate and amount of biomass produced (Dragan – Bularda, 2006).

Selected yeast *Saccharomyces bayanus* belongs to culture collection of Biotechnology Research Center and Microbiology of the Faculty of Agricultural, Food Industry and Environmental Protection, Lucian Blaga University of Sibiu.

Interpretation of results from mathematical models gives the possibility to predict the biothenologycal capabilities of yeasts in various intermediate stages, but their evolution under the influence of different types of vitamins.

MATERIALS AND METHODS

- *Saccharomyces bayanus* wine yeast

bioreactor type Biostat A, B. Braun Biotech International, equipped with a computerized system for monitoring, control and registration, equipped with sensors for temperature, dissolved oxygen, oxygen atmosphere, carbon dioxide, and biomass optical sensor recording.

The transformation of values read by optical sensor units biomass mass (g / l) is done with a calibration curve specific to wine yeast *Saccharomyces bayanus*

- Culture medium malt must enroll in the range used by the firm produced Scharlau Chemie SA,Spain containing malt extract 15 g / l, peptone 1 g / l maltose 12.5 g / l dextrin 2.5 g / l dipotassium phosphate 1 g / l ammonium chloride 1 g / l, pH 4.8.
- thiamine 0.5 mg / l
- biotin 0.5 mg / l
- inositol 0.5 mg / L

Four fermentation were noted with SBM (blank), SBB (sample enriched with biotin), SBT (sample enriched with thiamin), SBI (sample enriched with inositol). Working biological samples taken were activated in 200 ml of malt must for 24 hours at a temperature of 22^0C. All samples were brought successively in malt must in bioreactor Biostat A, B. Braun Biotech International equipped with temperature sensors CO_2, dissolved O_2, O_2 atmosphere, biomass, the reactor being scheduled to monitor fermentative activity for 10 days at 22^0C, the data being transferred to the computer (Tita, 2004).

There are three fermentative models obtained, witch were subsequently compared with results obtained after *Saccharomyces bayanus* yeast fermentation in not reached medium (Oprean, 2010).

RESULTS AND DISCUSSION

An important aspect in the growth rate of multiplication of yeast cells is to determine the optimal conditions for cultivation. It had established kinetic dependencies mono and multifactorial, which describes the influence of concentration of the basic components of the nutrient medium, temperature, the pH of culture medium, mixing intensity and the rate of multiplication of yeast.

As we can se from figure 1 biomass accumulation is strictly related to the composition of the culture.

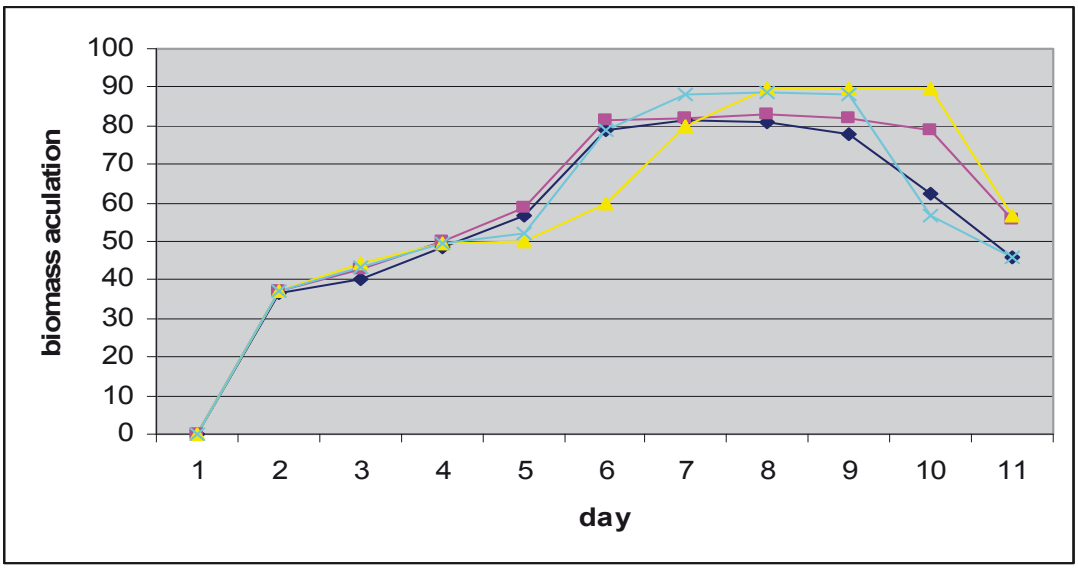

Fig.1 Biomass accumulation over a period of 10 days of the four types of fermentation

Addition of biotin, 0.5 mg / l leads to a close classical fermentation neighbors to blank, with the exponential growth phase until day 5 and on day 7 continues until the following to stabilize. Decline phase begins on day 8, with a slow involution.

It appears that the addition of thiamine can offer considerable benefits in terms of fermentation process and is a stabilizing factor in *Saccharomyces bayanus* wine yeast. So, the amount of thiamine controlled added in culture medium is a stimulating factor for the fermentation process, having a positive influence on the accumulation of biomass. Exponential phase development increase in day 6, the equilibrium phase lasts up to day 9 and the process of involution being shorter and suddenly, compared with blank .

Inositol stimulates the growth of yeast, inositol deficiency causing a weakening of glucose metabolism in both aerobic and anaerobic conditions.

Saccharomyces bayanus yeast fermentation activity is plotted in the equilibrium between days 5- 8 and the maximum amount of biomass accumulates on day 6 compared with blank. Connection between the two types of culture medium (X for MMA , pH -4,8 and Y for the medium where biotin was added) relative to the influence on the accumulation of yeast cells can be statistically expressed through covariance and the coefficient of correlation coefficient.

If we note Dxi the amount i of cellular biomass from X medium and with Dyi the amount of biomass i from Y medium, in day with the highest value where i=1;12, and with M(Dx) , M(Dy) the averages of cells on the two cultures we have:

M(Dx)=81,28 ; M(Dy)=82,82 and

$$\operatorname{cov}(X,Y)=\frac{1}{12}\sum_{i=1}^{12}(Dx_i-M(Dx))(Dy_i-M(Dy))=2{,}72$$

Having a positive covariance (cov(X,Y)=2,72>0), we can say that the biomass from both cultures has the same evolution . The bond strength can be established with correlation coefficient. First has to be calculated standard deviation on both culture medium:

$$\sigma(X)=\sqrt{\frac{1}{12}\sum_{i=1}^{12}(Dx_i-M(Dx))^2}=1{,}72 \quad \text{and}$$

$$\sigma(Y)=\sqrt{\frac{1}{12}\sum_{i=1}^{12}(Dy_i-M(Dy))^2}=1{,}86$$

Correlation coefficient will be:

$$\sigma(Y)=\sqrt{\frac{1}{12}\sum_{i=1}^{12}(Dy_i-M(Dy))^2}=1{,}86$$,that indicates a powerful bond(coefficient being defined on -1;1 interval.)

To establish the connection between culture medium blank and the one with thiamine added we calculate covariance and correlation coefficient between the two mediums. We note with X culture medium blank and with Y the one with 0,5 µg/l thiamine added.

If we note with Dxi cumulated biomass i from X medium and with Dyi cumulated biomass I from Y medium, where i=1:10, and with M(Dx) , M(Dy) the averages for the amounts of biomass on both cultures , we have:

M(Dx)=81,28 ; M(Dy)=89,67 and

$$\operatorname{cov}(X,Y)=\frac{1}{10}\sum_{i=1}^{10}(Dx_i-M(Dx))(Dy_i-M(Dy))=2{,}24$$

Because results a positive covariance we can say that the fermentation of *Saccharomyces bayanus* yeast from both culture mediums have the same evolution. The bond

strength is determinate with correlation coefficient , but first has to be calculated standard deviation on both culture medium:

$$\sigma(X)=\sqrt{\frac{1}{10}\sum_{i=1}^{10}(Dx_i-M(Dx))^2}=1{,}84 \text{ and } \sigma(Y)=\sqrt{\frac{1}{10}\sum_{i=1}^{10}(Dy_i-M(Dy))^2}=1{,}92$$

correlation coefficient will be

$$\rho_{XY}=\frac{\operatorname{cov}(X,Y)}{\sigma(X)\cdot\sigma(Y)}=0{,}958$$ and this indicates a powerful bond between the two because the coefficient is defined on (-1,1) ,

in inositol case we can establish the next bond by noting with Dxi cumulated biomass i from X medium and with Dyi cumulated biomass from Y medium, where i= 1:10, 1nd with M(Dx) , M(Dy) the averages of amounts of biomass on both culture medium, so we have:

M(Dx)=81,28 ; M(Dy)=88,43

$$\operatorname{cov}(X,Y)=\frac{1}{10}\sum_{i=1}^{10}(Dx_i-M(Dx))(Dy_i-M(Dy))=2{,}85$$

because results a positive covariance, we consider that the fermentation of *Saccharomyces bayanus* yeast from both culture mediums have the same evolution. The bond strength is determinate with correlation coefficient , but first has to be calculated standard deviation on both culture medium:

$$\sigma(X)=\sqrt{\frac{1}{10}\sum_{i=1}^{10}(Dx_i-M(Dx))^2}=1{,}84 \text{ and } \sigma(Y)=\sqrt{\frac{1}{10}\sum_{i=1}^{10}(Dy_i-M(Dy))^2}=1{,}98$$

correlation coefficient will be:

$\rho_{XY}=\frac{\operatorname{cov}(X,Y)}{\sigma(X)\cdot\sigma(Y)}=0{,}929$, $\rho_{XY}=\frac{\operatorname{cov}(X,Y)}{\sigma(X)\cdot\sigma(Y)}=0{,}958$ and this indicates a powerful bond between the two because the coefficient is defined on (-1,1) .

CONCLUSIONS

Additive vitamin contributes to the development of wine yeasts *Saccharomyces bayanus*, as is demonstrated also by the fact that a series of mathematical calculations predict the issue of their evolutionary trends. The amount of biomass depends on the type of biomass added in medium and on fermentation parameters. The input of vitamins is a positive factor in fermentation process so that they can be modeled on predicted days and values.

Biotechnological properties of wine yeast *Saccharomyces bayanus* are improving by adding 0,5µg/l thiamine , 0,5µg/l biotin, 0,5µg/l inositol in classic culture mediums.

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