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Pasteurization of Yeast by High Pressure Treatment

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Pasteurization of yeast by high pressure treatment was studied in comparison with that by heat treatment. *Saccharomyces cerevisiae, Candida tropicalis, Candida parapsilosis* and the yeast isolated from digestive tract (Japanese traditional fermented food, ika-siokara) were tested. The pressure survival curves of these yeasts showed to be sigmoidal. Considering D-values obtained from the regression analysis of survival curves, pressure stability of yeasts had a good correlation with heat stability. Z-values of these yeasts ranged from 80 to 100 MPa for high pressure pasteurization, 5 to 7 ℃ for heat pasteurization. A larger z-value means a weaker pressure effect.

Key words : yeast, high pressure, treatment, sterilization, heat treatment, D-value.

1. INTRODUCTION

Many attempts have been recently made to apply high pressure treatment for food processing because of it's retaining food's nutrients and taste [1–3]. Although there are many works about high pressure pasteurization, the pasteurization effect is still not completely elucidated. Whether pressure death kinetics of microorganisms follows first order reaction has not been obvious yet [4,5]. It is important to evaluate the pasteurization effect of high pressure treatment in comparison with that of heat treatment because heat treatment has been used mainly for commercial pasteurization in the food industry. But there are few reports concerning with the relationship between the pressure stability and the heat stability of microorganism.

In this study we examined the pasteurization of yeasts by high pressure treatment compared with that by heat treatment. The death kinetics of yeasts by pressure treatment was examined. D-values were calculated from the regression analysis of survival curves. The relationship between the pressure stability and the thermal stability of yeasts was examined from the D-values obtained. The influence of culture conditions and growth temperature on the pressure stability of yeasts was examined. Using the z-value obtained from pressure-death-time curves, we calculated time at different pressure for the pasteurization effect equivalent to 400 MPa–10min treatment.

2. MATERIALS AND METHODS

2.1. Microorganisms

Saccharomyces cerevisiae (JCM 1499), *Candida tropicalis* (JCM 1541), *Candida parapsilosis* (JCM 1618) were obtained from the Institute of Physical and Chemical Research (Wako, Japan). The yeast isolated from ika-siokara (IS) was identified as *Candida tropicalis*. They were grown in potato dextrose agar and broth, YM

agar and broth media (Difco, Detroit, USA) at 15, 25, 35 ℃. They were stored in a refrigerator until use. Suspension of yeast was treated with ultrasonication for 5 min. using Bransonic cleaner (60W, 45kHz) to break clump of yeast. Ultrasonicated sample was checked with microscope and laser particle size distribution analyzer LA-500 (Horiba, Kyoto, Japan).

2.2 High pressure treatment and heat treatment

The suspension of yeast was sealed in a plastic pouch and treated at 300, 350, 400, 450 and 500 MPa at 20 ℃ with high pressure test machine, MFP-7000 (Mitsubishi Heavy Industries, Hiroshima, Japan). The solution for suspension was 1/15 M phosphate buffer (pH 7.0) containing 5 % sodium chloride. During pressurization, the temperature within high pressure vessel raised by 5 ℃ because of adiabatic compression and when the pressure became constant, the temprerature was kept at about 20 ℃. Heat treatment was performed as follows: the suspension of yeast was injected into the same buffer as suspension of yeast in a test-tube preheated at a given temperature. And sampling of an aliquot was carried out at a time interval. After treatment, the sample was incubated by plate-counting method for enumeration of survivor of yeast. Potato dextrose agar medium was used, and the sample was cultured at 25 ℃ for 3 or 4 days.

3. RESULTS AND DISCUSSION

3.1 Survival curves of yeasts

Survival curves were shown to be sigmoidal at 300 and 350 MPa (Fig. 1). We obtained these results of experiment used the yeast isolated from ika-siokara. As to other yeasts similar results were obtained. The influence of clump of yeast on type of survivor curve was studied with ultrasonicated sample and untreated sample. The linearity was improved slightly but the curve was sigmoidal basically. The survival curve tended to be more linear when the pressure was higher. Heat treatment also did not show linear curve (Fig. 2). Although the cause that these curves are sigmoidal is unclear, it seems to be due to other causes for example the heterogeneity of pressure stability of yeast [6].

3.2 Influence of culture conditions on pressure stability of yeasts

The influence of growth temperature and culture medium on pressure stability of yeasts was examined. The influence of growth temperature on the pressure stability of *S. cerevisiae* was shown in Fig. 3. The pressure stability of the yeast cultured at 35 ℃ was higher than that at 15 and 25 ℃. The result obtained on heat stability test was similar. The cell size and composition of cell membrane may be concerned with the higher pressure stability of yeast grown at higher temperature [7].

3.3 Relationship between pressure stability and heat stability of yeast

To represent pressure stability and heat stability of yeast, we used the pressure and temperature at which D-value was 1 min., respectively. The pressure stability of yeasts had high correlation with the heat stability (correlation coefficient: 0.853) as shown in Fig. 4. The z-values of these yeasts ranged 80 to 100 MPa in

high pressure treatment, 5 to 7 ℃ in heat treatment. There was no good correlation in z-values between pressure pasteurization and heat pasteurization. A larger z-value means a weaker pressure effect. In case of z-value equal to 80 MPa, the pressure-time combinations for pasteurization effect equivalent to 400 MPa-10min treatment at ambient temperature were shown as Table 1. For application of high pressure treatment in food processing, operation condition at lower pressure is desirable from the viewpoint of equipment cost. However, a longer time treatment is required to pasteurize yeasts at lower pressure. Also elevation of pressure by 80 MPa is more difficult than that of temperature by 5

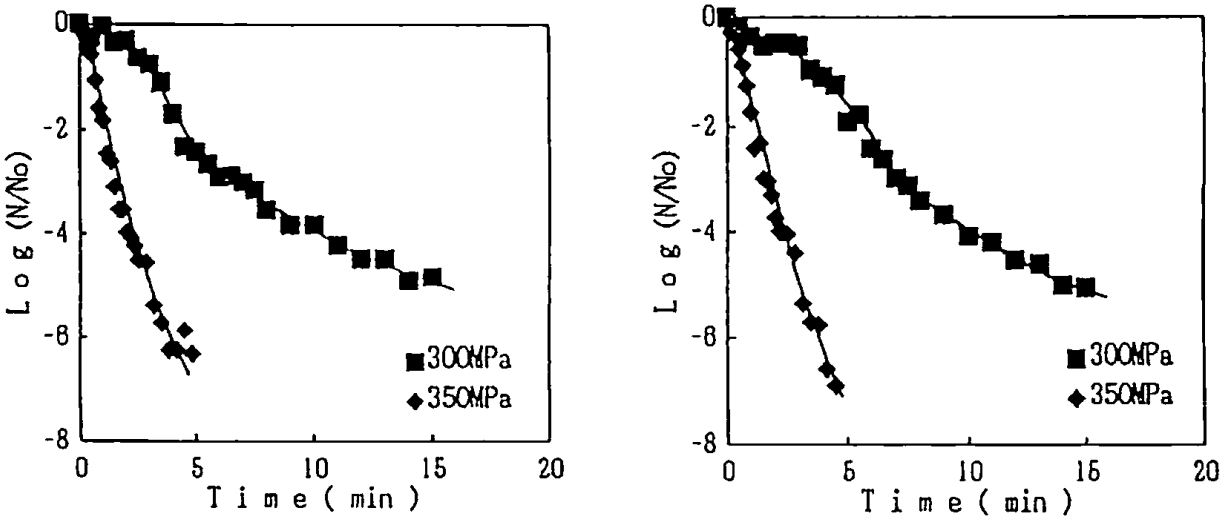

Fig. 1. Survival curves for the yeast isolated from ika-siokara in 1/15 M phosphate buffer (pH 7.0) containing 5% sodium chloride at 300, 350 MPa.
Left: untreated sample, Right: ultrasonicated sample

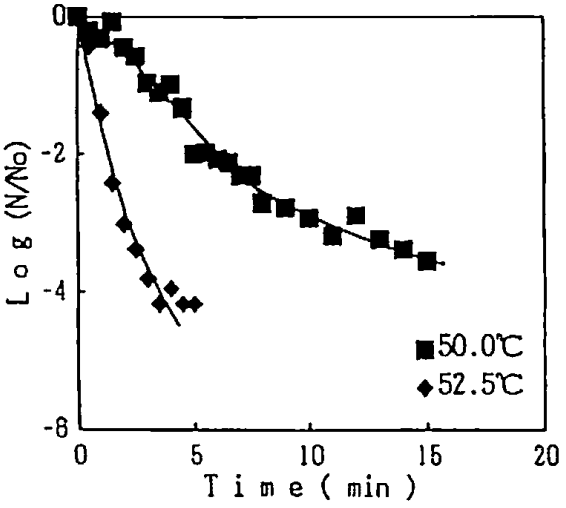

Fig. 2. Survival curves for the yeast isolated from ika-siokara in 1/15 M phosphate buffer (pH 7.0) containing 5% sodium chloride at 50, 52.5℃.

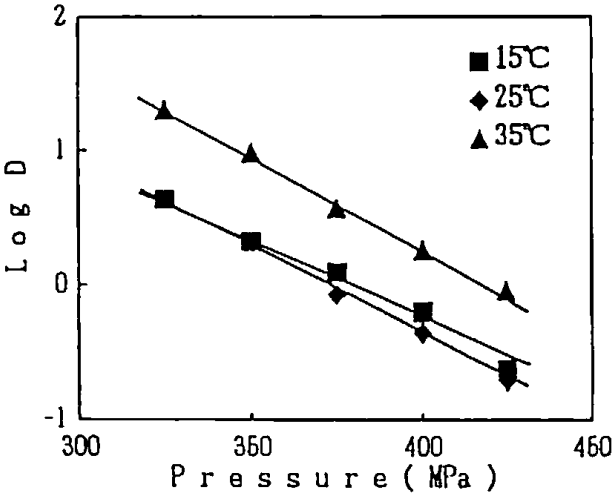

Fig. 3. Pressure-death-time curves (z-values) for *S. cerevisiae* grown at different temperature.

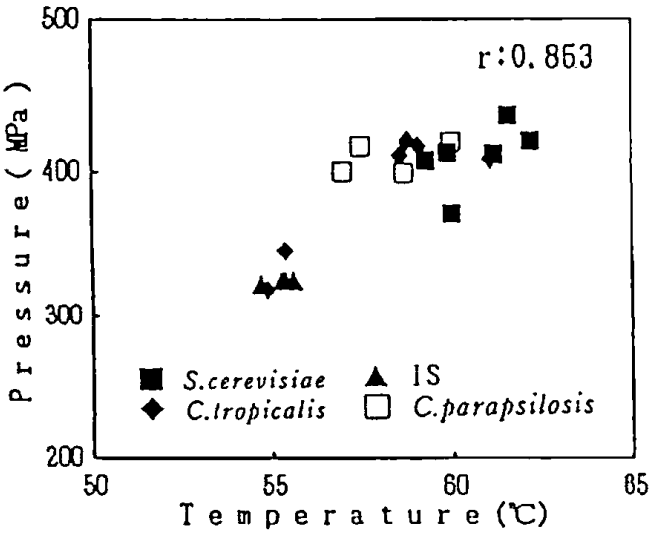

Fig. 4. Scatter plot of the pressure and temperature corresponding D-value to 1 min, respectively (relationship between pressure stability and heat stability of yeasts).

Table 1. Pressure-time combination giving pasteurization effect equivalent to 400 MPa-10min treatment at ambient temperature. (z-value = 80 MPa)

Pressure (MPa)	Time (min)
300	178
350	42
400	10
450	2.4
500	0.56

℃. So, high pressure treatment at ambient temperature is more unfavorable than heat treatment.

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