

Effect of Sterilization of Mongolian Traditional Wine(Airag) Using HV Impulse Characteristics

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Abstract—In the sterilization system by using HV impulse waveform Mongolian traditional wine (airag) was sterilized with HV discharged oscillatory decay waveform. The critical condition of impulse waveform for electrical sterilization has presented a smaller survivability at 20kV, 4mH and over. The characteristic of this waveform shows oscillatory decay waveform with multiple pulses. And this impulse waveform was more effective to kill yeast cell than exponential decay waveforms. This impulse waveforms are applied into chamber during the charging and discharging period. *Zygosaccharomyces rouxii*, a yeast cell to become musty for Mongolian Airag was used as the sample. Airag is not proper to be thermally sterilized because specific spidery property and the fact is that the stored property make improve with an artificial preservative. But this liquid drink has good effect of electrical sterilization because of high conductivity. Therefore this experiment can be treated sterilization without loss of original taste and perfume to Airag. As a result, it is found that *Zygosaccharomyces rouxii* for Mongolian Airag can be sterilized on 20kV, 4mH and over by using our designed HV impulse sterilizer.

Keywords—Mongolian Airag; Sterilization; HV impulse; *Zygosaccharomyces rouxii*; exponential decay; multiple pulses;

I. INTRODUCTION

According to Sale and Hamilton.the condition of sterilization is determined by the product of the pulse length and number of pulses and by the field strength in the suspension [1]. Before we have evaluated the survival ratio of E.coli depend on the characteristics of RC and RLC circuit [4]. The result of that experiment is appeared RLC circuit better than RC circuit in E.coli sterilization [3]. RLC circuit with oscillating parameters, which consists of a capacitive energy storage source and a inductive pulse duration and a resistive cell suspension chamber has been widely used for a discharging network. RLC circuit shows multiple pulses(although decaying) are available during the charging and discharging between capacitor and inductance with chamber containing cell suspension.

Especially, this multiple pulse has the high efficiency for the same stored energy in capacitor whereas, conventional RC circuit has only single pulse is available by discharging energy stored in capacitor to treatment chamber containing cell suspension[4-5]. Therefore the RLC condition is considered one of the most important point to be investigated for electrical sterilization by HV impulse. The authors carried out an experiment to sterilize the Airag using our sterilizer consists of RLC network. Mongolian Airag using to be fermented horse judge which is one of the popular traditional wine in mongolia.

But Mongolian Airag has the limited storage life which resulted from the store because of manufacturing without fired store process or because of being microorganism contaminated by manufacturing process. And especially, what we call *Zygosaccharomyces rouxii* well known to the general public as to acidify the Airag possessed the characteristics of only well living in fermented wine. So it is very important to sterilize the *Zygosaccharomyces rouxii* for the good quality of Airag. Generally, in the manufacturing company, there make an attempt at improvement in the preservation of Airag by means of heat treat. But sterilization by heating has the point at issue to be deteriorate the quality of Airag because of oxidizing or resolving the ingredients of Airag by heating and because of various mineral or vitamin degeneration, loss of original taste and perfume. Therefore this experiment can be treated sterilization without such a point at issue. Especially, in this study the sterilization system was operated continuously by using peristaltic pump. Of course, though we think that the characteristic of this *Zygosaccharomyces rouxii* is different from E.coli, the purpose of this work is to find application of HV impulse waveforms for other cell, *Zygosaccharomyces rouxii*.

II. EXPERIMENTAL APPARATUS AND PROCEDURE

Fig.1 shows schematic diagram of experimental apparatus. In HV impulse generator, C_0 (=0.1 μ F) of

condenser was charged from dc high voltage source and discharged into the electrode (=chamber) by HV transistor switch. In this case, the pulsed

voltage was decayed by time constant ($=C_0R$). R and C are fixed, while only L value is changed from 0 to 20mH. Gap distance of electrode in chamber is adjusted to 1 mm. The repetition rate of semiconductor switch is operated as follows;

$$T = nt \quad (1)$$

(T - treatment time, n- number of pulse, t- pulse width),

$$n = fV \quad (2)$$

(n- number of pulse, f- number of frequency, V- volume(mL) of container, m- flux(mL/s) and pulse was 10us.

The sample in the shocked suspension is diluted to 10-6range. The 0.1ml of sample are transferred to the surfaces of Yeast malt Agar plates and spread over the surface of agar with a sterile glass rod. Then the plates are incubated at a temperature of 30°C for 5 days and the numbers of colonies are counted.

Therefore the influence of HV impulse on the Zygocaccharomyces rouxii has been measured as a survival ratio($S=N/N_0$, where N and N_0 are a number of active microbes per unit volume after and before the voltage treatment respectively)

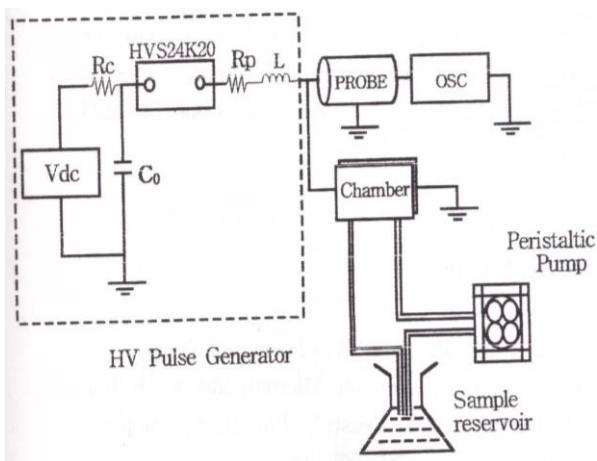


Fig. 1. Schematic diagram of experimental apparatus.

III. RESULTS AND DISCUSSION

In this experiments the energy stored in the capacitor ($1/2 CV_0^2$) is used as the energy input to the suspension by one pulse. The energy input was 20J at $V_0=20kV$ and 5J at $V_0=10kV$. In the same condition fig.2 illustrates that the survivability decrease with the change in the treatment time. For example in case of 15kV the survivability decreases by 2.5orders of magnitude within the range of treatment time 1000

to 4000 μs . And in case of the same condition on 2000 μs , the survivability decreases by 3 orders of magnitude within the range of voltage 5 to 20kV.

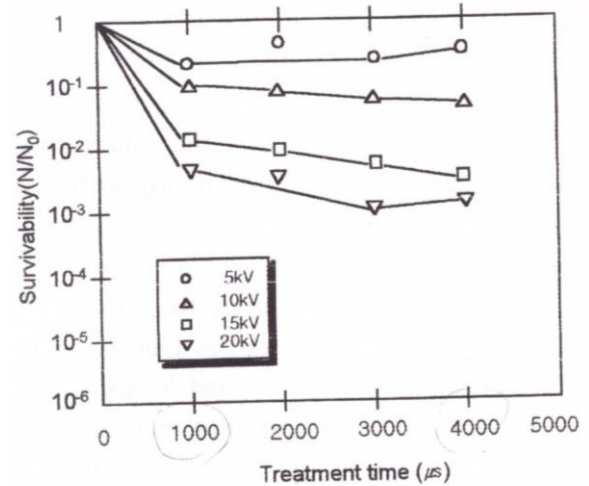


Fig. 2. Survivability on electric field strength against treatment time.

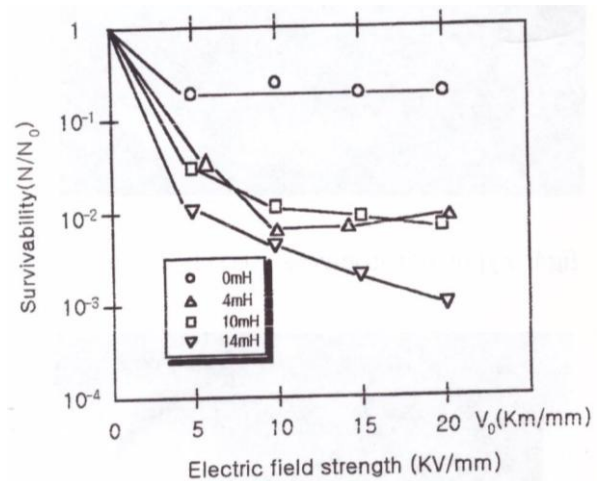


Fig. 3. Survivability on inductance value against electric field strength.

In fig.3 the survival ratio of E.coli is shown as function of the inductance value against electric field strength. The number of pulses applied was $n=20$ for each value the survivability depends insignificantly on the number of pulses.

In case of 14mH, the survivability decreases by 3 orders of magnitude even for 20kV. For 0mH a decrease of 0.7 order takes place for 5kV to 20kV. It is evident that the survivability decreases by 3 orders of magnitude within the range of inductance 0 to 14mH.

But in case of 4mH and over.the survivability is shown to decrease of 2 orders than that of 0mH. As shown in figure 4 and 5 electric field strength with high L value has sterilized more Zygocaccharomyces rouxii cell than treatment time.

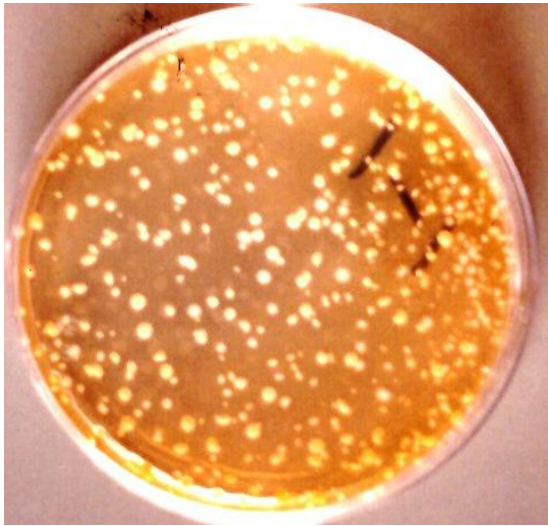


Fig. 4. *Zygococcus rouxii* for no shock.

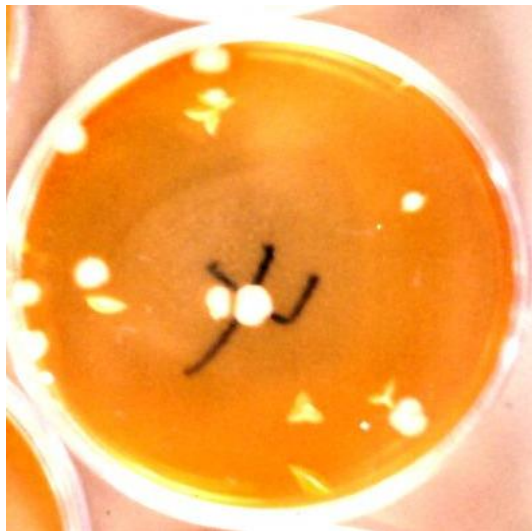


Fig. 5. *Electrical shock for 20kV, 14mH applied.*

IV. CONCLUSION

In this continuously recycling operation system, it is appeared that the survivability increases as growth of treatment time with drawing of a slow curve similar to straight line. It means that the sterilization does not happen because the treatment time is long and it shows that the factor of electric field strength has a great influence than the treatment time.

And finally, it is found that the survivability of *Zygococcus rouxii* being tested decreases with an increase in L value of 4mH and over.

Therefore, in this method, it has advantage capable of long time preservation circulation Mongolian Airag is processed using high voltage discharge decayed oscillatory wave controlling the RLC parameter and is obtained with nonthermal sterilization the low temperature cure of food is possible and the deterioration of food can be prevented.

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