

Influence of Water Potential in Potato Tuber on Decay Development by Bacterial Soft Rot Caused by *Erwinia carotovora* var. *atroseptica*

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감자軟腐病(*Erwinia carotovora* var. *atroseptica*)에 의한
감자塊莖腐敗와 water potential에 관한 研究

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ABSTRACT: Results obtained from the experiment conducted to find out the relationships between tuber decay, and water potential and bruising in or on the tubers, are summerized as follows; 1) When potato tubers were bruised or injected with bacterial inoculum, the tubers with high water potential rotted more easily than the tubers with low potential. A big difference in the development of decay between high and low water potential tubers was found. 2) In tubers injected with different levels of inoculum, high water potential tubers were more susceptible to soft rot than low water potential tubers. 3) ED₅₀ of inoculum concentration was 8.5(log) at high water potential tubers and 9.8(log) at low water potential. A small difference between low and high water potential was detected. The results of this experiment show that potatoes should be handled carefully and must be dried after harvest to reduce decay development in shipment and storage.

INTRODUCTION

Potatoes are usually shipped or stored at a temperature of 4.4 °C shortly after harvest. Decay of potato tubers due to bacterial soft rot in storage or in transit is generally considered to be caused by bacteria described by Lolliott⁶⁾ as *E. carotovora* var. *carotovora*, *E. carotovora* var. *atroseptica* and other pectolytic bacteria, particularly clostridia^{7,8,9,10)}.

Several researchers^{2,3,5,8,11)} pointed out the importance of careful handling throughout all stages of tuber harvest, storage and shipping of potato tubers. Lund and Kelman⁸⁾ reported that tubers had passed through a flume system and a rinsing spray in a commercial packing plant had a greater decay potential, even after passage through a ho-

tair drier than unwashed potatoes. They also noted differences in decay potential between mechanically harvested potatoes and manually harvested potatoes.

DeBoer and Kelman¹⁾ showed that changes in relative humidity had no effect on the diameter of decay induced by injecting five levels of inoculum into tubers. But they found that the decay at 16 °C developed significantly faster than at 10 °C.

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MATERIALS AND METHODS

Water potential in tuber: Potato tubers

used were Russet Burbank harvested at Arlington Experimental Farm on 16th October, 1978. Before using, all potatoes were washed with tap water and dried out at room temperature for 24 hours. Half of them for high water potential were stored in a cold room (4.4 °C) in a covered container. The remainder were used for low water potential studies and were stored in an air circulating room (16-20 °C) for 10 days. The water potential of these two groups of potatoes were measured with a Dew Point Microvoltmeter (HR-33T).

Inoculum : The inoculum (*E. carotovora* var. *atroseptica*) used in this experiment was obtained from Dr. Kelman. Before starting the inoculations, the inoculum was tested for its virulence on both tubers and antiserum of *E. carotovora* var. *atroseptica*. Tubers inoculated produced typical symptoms. A typical serological reaction of agglutination was observed by using Latex Agglutination Test ⁴⁾.

Dilutions of bacterial suspension were determined by the methods described by DeBoer and Kelman ¹⁾ -- using 100 lambda disposable capillary pipettes (Clay-Adams), five inoculum levels (10^3 , 10^5 , 10^7 , 10^9 , 10^{11} cells per ml) were injected to a depth of 1.5 cm into one side of the tuber at five random sites.

Treatments : 80 tubers stored in cold room and 80 tubers stored in air circulating room were treated, respectively, as follows ;

1) 20 tubers from each group in cold room and air circulating room were injected with five inoculum levels as mentioned above.

2) 20 tubers from each group were only bruised (banged) by a banging machine.

3) 30 tubers from each group were banged and then dipped in bacterial suspension (10^7 cells per ml) for 1 minute.

4) The control group consisted of 20 untreated tubers.

Measurement of rotted areas on tuber :

1) All treated tubers were placed in mist chamber at the temperature 16 to 18 °C for 4 days.

2) Diameter of decay was measured at the widest point after cutting vertically through each injection point at right angle to the injection.

RESULTS AND DISCUSSION

The water potential- two batches of Russet Burbank were used. Batch A was sampled from tubers stored in a cold room, and batch B from tubers stored in an air circulating room for 10 days. The mean water potential based on tubers from each batch was -6.06 bars for high water potential tubers

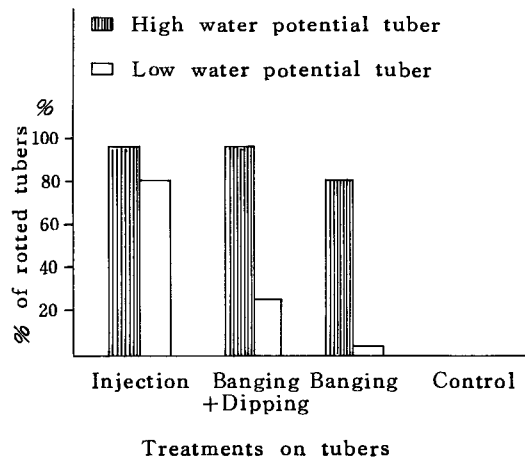


Fig. 1. Relationship of water potential in potato tuber and decay development in Russet Burbank potatoes 4 days after treatments in mist chamber.

* Injection = Tubers were injected with bacterial suspension (10^7 cells per ml).

Banging = Tubers were banged with banging machine.

Banging & Dipping = Tubers were banged and then dipped in bacterial suspension for 1 minute.

and -6.46 bars for low water potential tubers, respectively. The results presented in Fig. 1 show that high water potential tubers in all treatments seemed to be more susceptible to soft rot than low water potential tubers although there was only a slight difference in tubers injected with bacterial suspension. Nevertheless, about 10 percent difference in decay development could be found in all treatments.

In the control group, there was no decay development. This indicates that injury was the main entrance for the bacteria^{2,3,5, 8,11}.

Table 1 also shows that water potential and inoculum levels are correlated to decay development. The data shows that the percentage of rotted tubers in high water potential tubers is higher than in low water potential tubers.

Table 1. The relationship of water potential and different inoculum levels to decay development in Russet Burbank potato tubers 4 days after injection with *E. carotivora* var. *atroseptica*.

Treatment #	High water potential (tuber)					Low water potential (tuber)				
	1	2	3	4	5	1	2	3	4	5
Ino. conc. $\frac{\text{CFU}}{\text{ml}}$	10^{11}	10^9	10^7	10^5	10^3	10^{11}	10^9	10^7	10^5	10^3
Sample #	1	+	+	+	+	+	+	+	0	+
	2	+	0	0	0	0	+	0	0	0
	3	+	+	0	+	+	+	0	0	0
	4	+	+	0	+	+	+	+	0	0
	5	+	0	0	0	0	+	+	+	0
	6	+	+	0	+	0	+	+	0	0
	7	+	+	0	0	0	0	0	0	0
	8	+	0	0	0	0	+	0	0	0
	9	+	0	0	0	0	0	0	0	0
	10	+	+	+	0	0	+	+	+	0
	11	+	0	+	0	0	+	0	0	0
	12	+	+	+	0	0	+	+	0	+
	13	+	+	+	0	+	0	0	0	0
	14	+	+	+	+	+	+	0	0	0
	15	0	+	0	0	0	+	0	0	0
	16	+	+	0	0	+	+	0	0	0
	17	+	+	0	0	0	+	+	0	+
	18	+	+	0	0	0	+	0	0	0
	19	+	+	+	0	0	+	0	0	0
	20	+	+	0	0	0	+	0	0	0
Total	$\frac{19}{20}$	$\frac{11}{20}$	$\frac{7}{20}$	$\frac{5}{20}$	$\frac{5}{20}$	$\frac{16}{20}$	$\frac{7}{20}$	$\frac{3}{20}$	$\frac{3}{20}$	$\frac{2}{20}$
Percent (%)	95	55	35	25	25	80	35	15	15	10

+ : Rotted tuber 0 : Healthy tuber

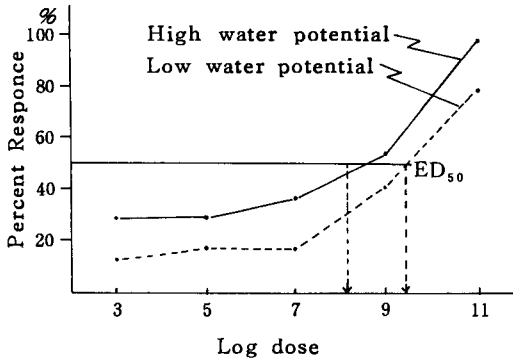


Fig. 2. Relationship of water potential and inoculum concentrations to decay development. (Percent Response vs. Log dose)

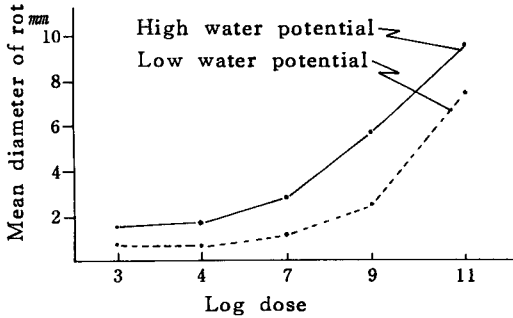


Fig. 3. Relationship of inoculum concentration to mean diameter of decay at two different water potential. (Mean diameter of rot vs. Inoculum concentrations)

A significant difference between high water potential and low water potential was observed. Some differences were also found in the relationship between water potential and inoculum concentration in the development of decay (see Figure 2). The ED_{50} in high water potential tubers was $10^{8.5}$ cells/ml and ED_{50} in low water potential tubers $10^{9.5}$ cells/ml. Figure 3 shows that there were some differences in mean diameter of rotted areas between high water potential and low water potential at different levels of inoculum.

摘 要

감자 괴경에 타박상을 입혔거나 세균 현탁액을 주입했을 때 낮은 water potential (-6.46 bar) 보다 높은 water potential (-6.06 bar) 에서 더 쉽게 부패를 초래하였으며, 높은 water potential 을 가진 괴경과 낮은 water potential 을 가진 괴경 사이에 있어서의 부패의 진전에는 큰 차이를 발견할 수 있었으며, 현탁액의 농도의 종류에 따른 괴경의 연부병의 이병정도는 높은 water potential 에서 높았으며, 세균 현탁액 농도의 ED_{50} 은 높은 water potential 에서 $10^{8.5}$ cells/ml 이며 낮은 water potential 에서는 $10^{9.5}$ cells/ml 이었으며, 높은 water potential 과 낮은 water potential ED_{50} 에서는 작은 차이를 인정할 수 있었다.

이 시험에서 감자는 상처나 타박상이 나지 않도록 다루어야 하며 수확후 충분히 건조하여야 오랜 운반과 저장중에 연부병 발생을 크게 줄일 수 있다는 것을 나타낸다.

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