BACTERIAL SOFT ROT OF POTATOES IN TRANSIT AND IN STORAGE 1/

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Conclusions for Control

1. Tuber injury should be avoided since wounds are sites which initiate bacterial soft rot.

2. Large numbers of bacteria including rotters are present normally on tuber surfaces and beneath the skin layer. Surface disinfestation of tubers as a means of preventing soft rot development would not kill the bacteria below the skin.

3. Tuber surfaces should be dried as soon as possible after washing if tubers are going to be stored above 45°F.

4. Tubers not dried should be cooled down to 40 to 45°F as soon as possible after washing.

5. Tubers should be stored or shipped under well ventilated conditions to prevent rapid increases of bacterial soft rot.

Introduction

The investigation on the bacterial soft rot problem in rail car shipments of potatoes began July 1, 1966 and was continued through August 1970. Preliminary findings were reported in 1967 3/ and 1968 4/. Objectives were to determine causal agent (s), to determine environmental factors involved and to develop control measures.

Railcar reinspection certificates were analyzed to determine the extent of the shipping problem during the 5-year period, 1965 to 1969 5/. Due to the difficulty in properly distinguishing various kinds of soft rot (leak, slimy soft rot, water rot, and bacterial soft rot) at the terminal markets, these were grouped together as tuber decay.

The analysis of reinspection certificates revealed that approximately 5% of the cars shipped each year were rejected due to tuber decay, except in 1966, 10% of the cars shipped were rejected (Fig. 1). Approximately 11% and 7% of the cars loaded with Russet Burbank were rejected in 1968 and 1969, respectively, as compared with 1% and 4% rejections of cars loaded with Norgold Russet (Fig. 2).

Shipping Studies

Shipping studies showed that when sacked potatoes were shipped under mechanical refrigeration or when chilled and loaded in an iced car the floor temperatures dropped the most rapid. Icing cars

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1/ This investigation was made possible through grants supplied by the Washington State Potato Commission.

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3/ 1967 Washington State Potato Conference Proceedings pp. 127-135.

4/ 1968 Washington State Potato Conference Proceedings pp. 67-80.

5/ Based on Records provided by Mr. W. J. Irey, Supervisor, Fresh Products, Federal State Inspection Service, Olympia, and Mr. Fred Ramsey, Manager, Washington State Potato Commission, Moses Lake, Washington.

either prior to loading or after loading were less effective in lowering temperatures (Fig. 3 and 4).

Kinds of packaging may also affect cooling rates of tubers. Temperature studies in a rail car loaded with 315 - 100 lb. sacks and 370 - 50 lb. cartons showed that temperatures in the cartons dropped from 79 to 70°F, while floor temperature dropped from 78 to 50°F after 4 days (Fig. 5).

Oxygen Studies

Tubers placed in plastic bags and sealed utilized oxygen rapidly in the atmosphere surrounding the tubers (Fig. 6). The higher the temperature at which tubers were stored the greater the rate of oxygen utilization. Further tests showed that tubers rotted considerably faster under low oxygen (2%) as compared with those held under normal oxygen level (20.5%) (Fig. 7).

Low levels of oxygen were not found in cars shipped with sacked potatoes 1/, however, it is possible that low oxygen levels could be encountered when tubers are packaged in plastic bags or other "air tight" containers.

Moisture and Temperature Effects on Soft Rot Development

Laboratory tests showed that tubers with dry surfaces did not develop bacterial soft rot either at low (4%) or normal (20.5%) oxygen levels 2/ or at any temperature tested (40 to 70°F) following 11 days incubation (Fig. 8). The amount of rot which developed when tubers were stored under wet conditions was directly related to the storage temperature. It required storage temperatures of 50°F or below to greatly reduce or prevent bacterial decay (Fig. 8).

Prestorage Factors Affecting Soft Rot Development

Wet tubers, when incubated or 0, 1, 2, or 3 days at 70°F, then placed in storage chambers at 40, 50, 60, or 70°F for 8 days, showed that prestorage treatments greatly affected bacterial soft rot development (Fig. 9). Little nor no rot developed when wet tubers were stored at 40 or 50°F with no prestorage treatment, however, over 10% rot occurred when wet tubers were placed in 50°F storage following one day prestorage. A storage temperature of 40°F was not sufficient to prevent soft rot development when tubers received 2 or 3 days prestorage treatment.

Presence of Rotters and Nonrotters on Tuber Surfaces

Isolations made from tuber surfaces not disinfested showed that large numbers of bacteria (greater than one million per gram of tissue) are normally present. Although the greater portion of the bacteria are nonrotters a significant number (approximately 1%) are rotters (Fig. 10). When tubers are incubated under wet conditions at 73°F for 8 days there is an increase in total bacterial population and a change in dominant types from type A nonrotters (Brevibacteriacea and Corynebacteriaceae) to type B nonrtotters (gram negative aerobes). There was little change in relative numbers of rotters (Erwinia spp., pseudomonads, and a yellow ochre type) after 8 days incubation.

Effects of Tuber Disinfestation on Soft Rot Development

The population of bacteria from nondisinfested tuber surfaces was one million per gram of tissue at 0 day of incubation and increased to over 100 million by the 6th day (Fig. 11). When tuber surfaces were either disinfested (20% Clorox for 15 minutes, rinsed in sterile water, dipped in 70% ethanol for 15 minutes and then dipped in 95% ethanol and flamed or peeled and disinfested (as above),

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1/ 1968 Washington State Potato Conference Proceedings pp. 76-80.

2/ 1967 Washington State Potato Conference Proceedings pp. 127-135.

bacteria were not detected until the 4th day of incubation of wet tubers at 73°F. By the 6th day, numbers of bacteria reinfesting the treated tubers exceeded the numbers on untreated tubers by more than 10 million per gram of tissue. Present among the bacteria reinfesting the treated tubers were rotters (Erwinia spp. pseudomonads, and Bacillus spp.) and nonrotters (pseudomonads, other aerobes and facultative anaerobes).

Injury

Although injury was not studied, it was apparent from many observations that most of the bacterial soft rot development was initiated at injury sites on the tuber surface.

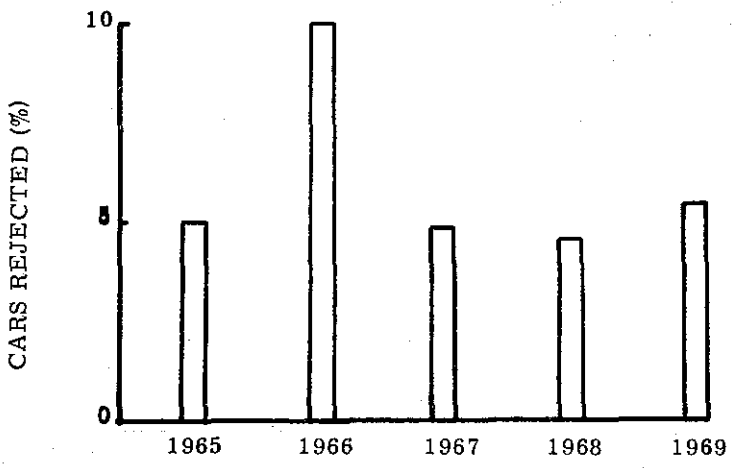


Figure 1. Cars rejected (%) due to Tuber decay 1965-1969.

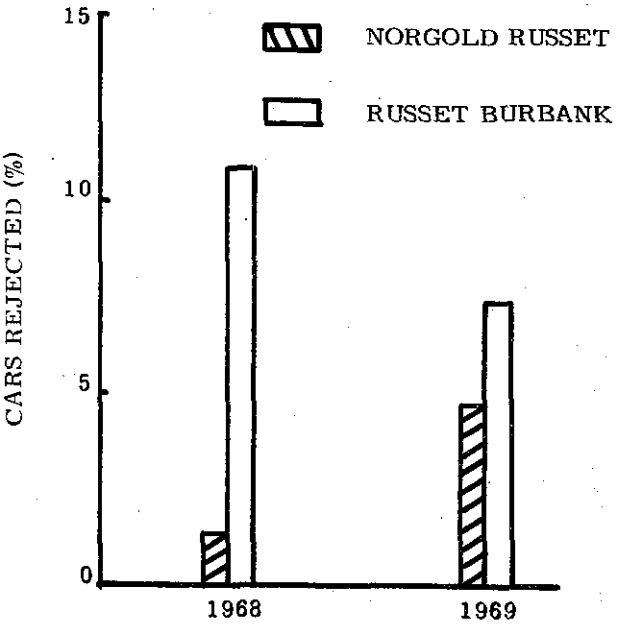


Figure 2. Cars rejected (%) of Norgold Russet and Russet Burbank varieties in 1968 and 1969.

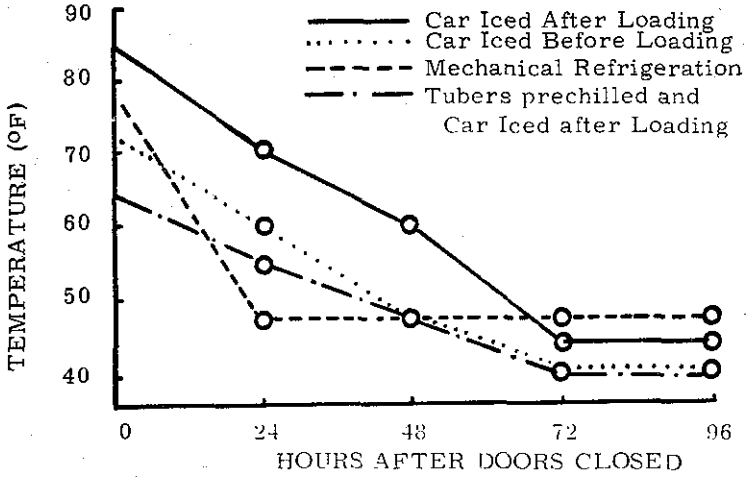
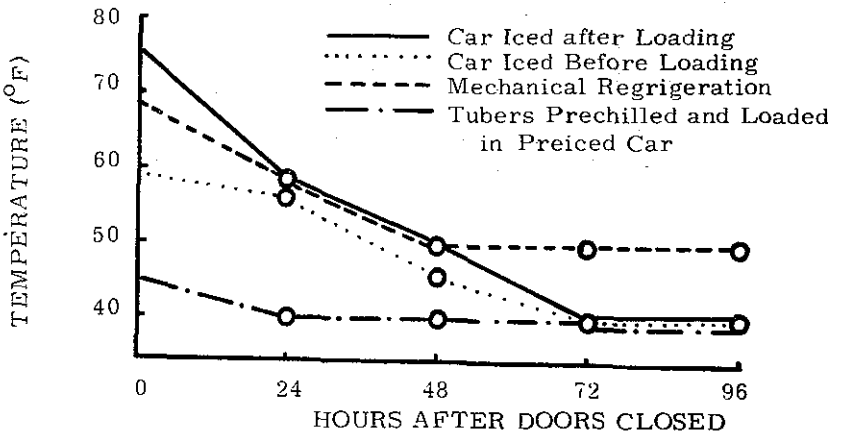


Figure 3. Effect of Cooling methods on floor temperatures in rail cars loaded with sacked tubers at Pasco 8/16/1967.

Figure 4. Effect of cooling methods on floor temperatures in rail cars loaded with sacked tubers at Pasco 8/25/1967.



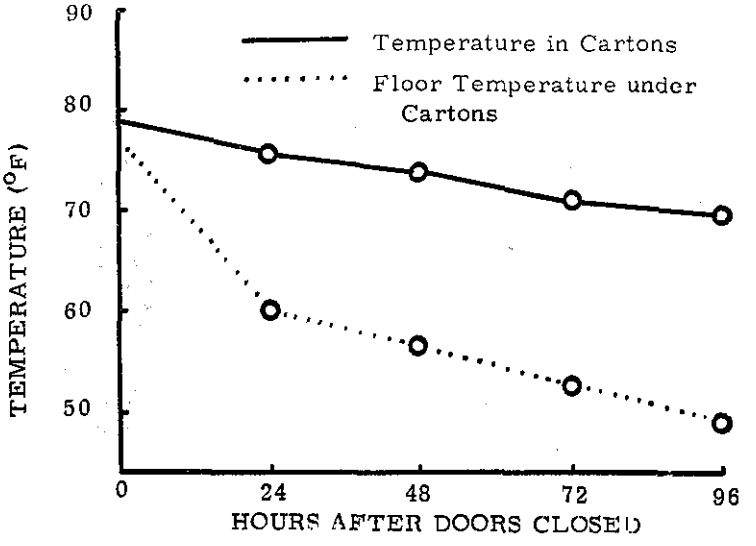


Figure 5. Effect of packaging on cooling rates of tubers in a rail car loaded with sacks and cartons at Othello 9/6/1967.

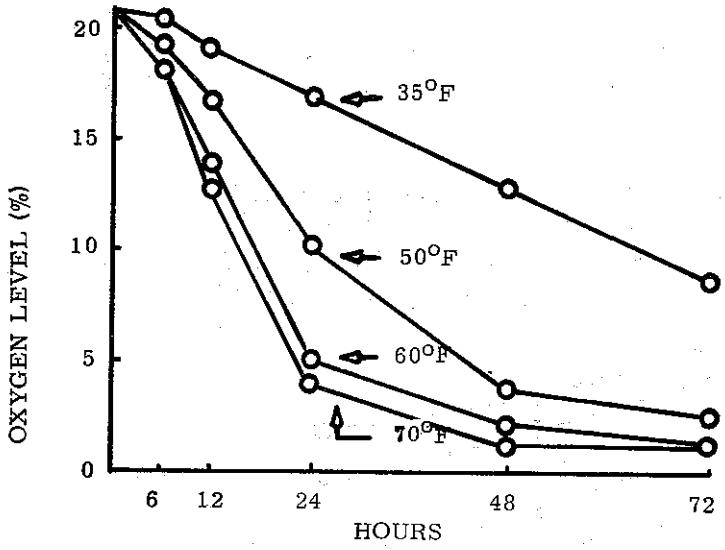
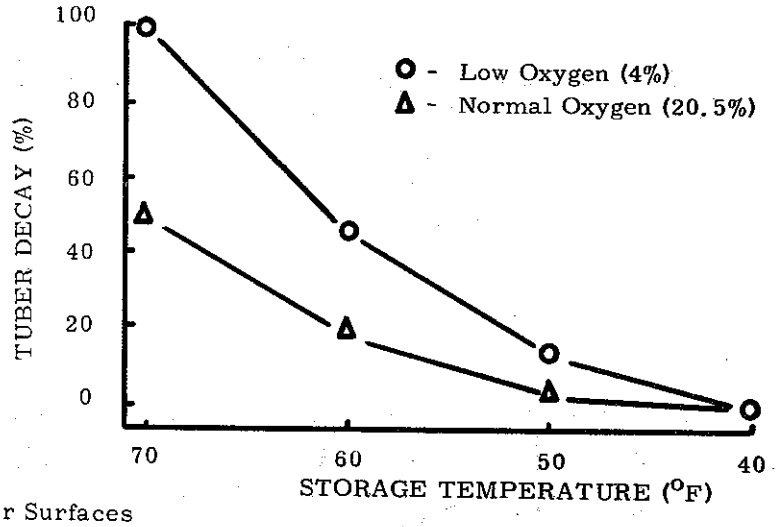


Figure 6. Effect of temperature on oxygen utilization by tubers held at various temperatures.

Figure 7. Effect of oxygen level on soft rot development.



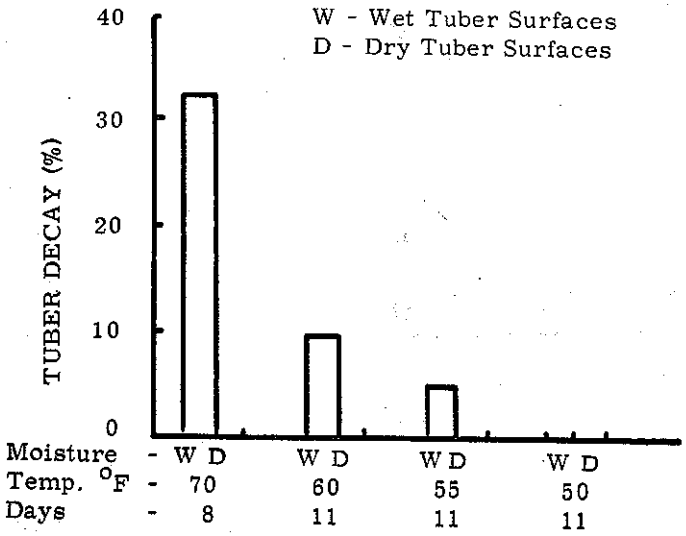


Figure 8. Effect of moisture and temperature on bacterial soft rot development of tubers.

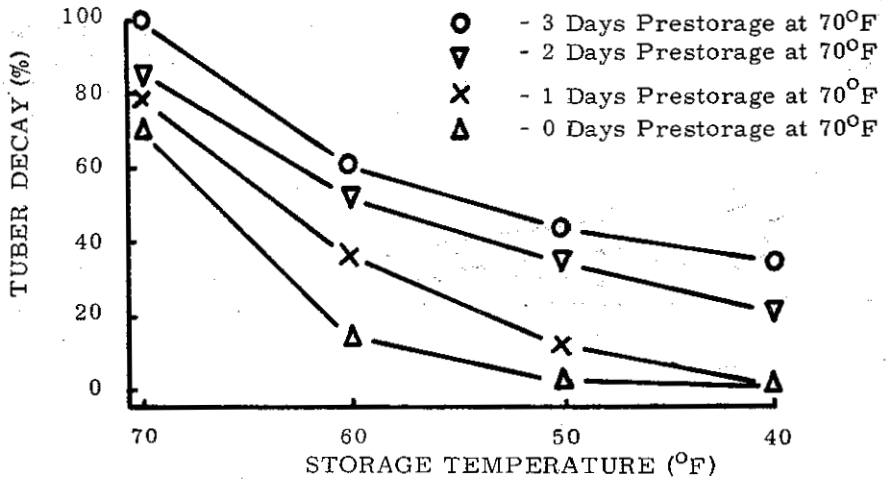


Figure 9. Effect of prestorage treatment on soft rot development of tubers stored under wet conditions.

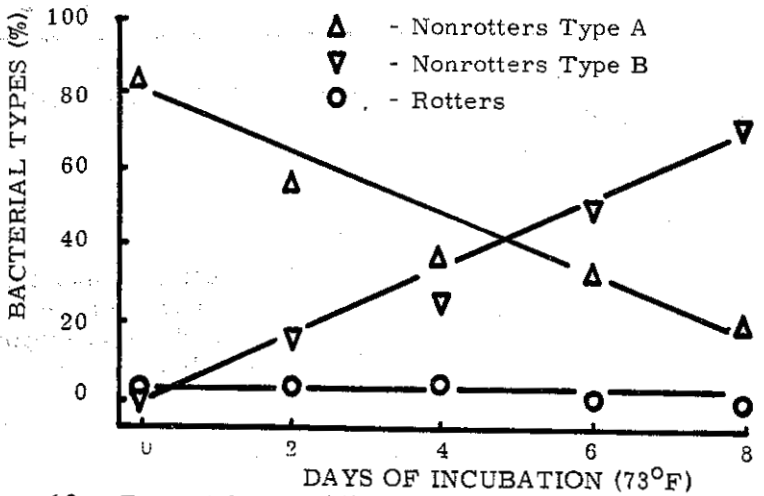


Figure 10. Bacterial types (%) on moist tubers not disinfested.

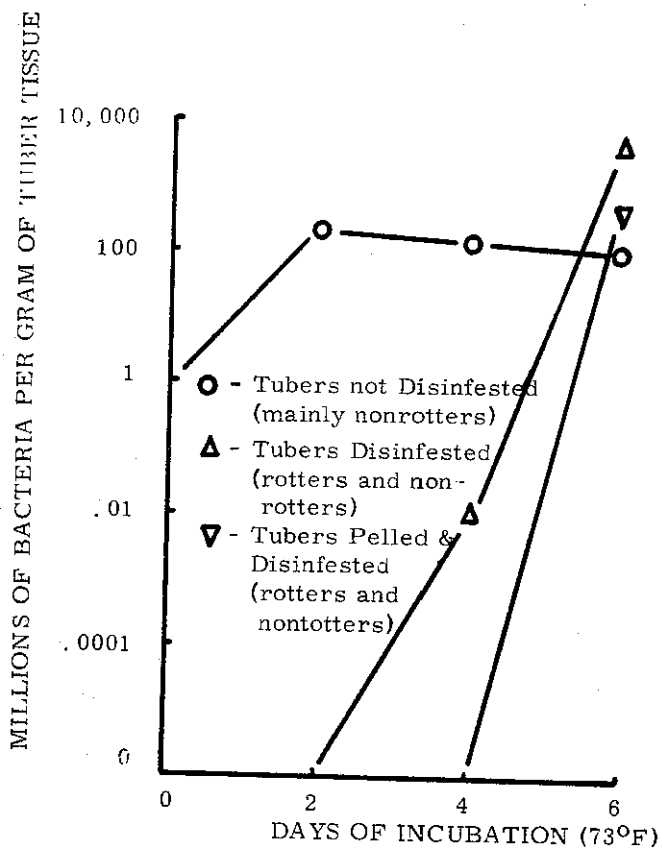


Figure 11. Number and types of bacteria on not disinfested, disinfested, and peeled and disinfested tubers incubated under wet conditions.