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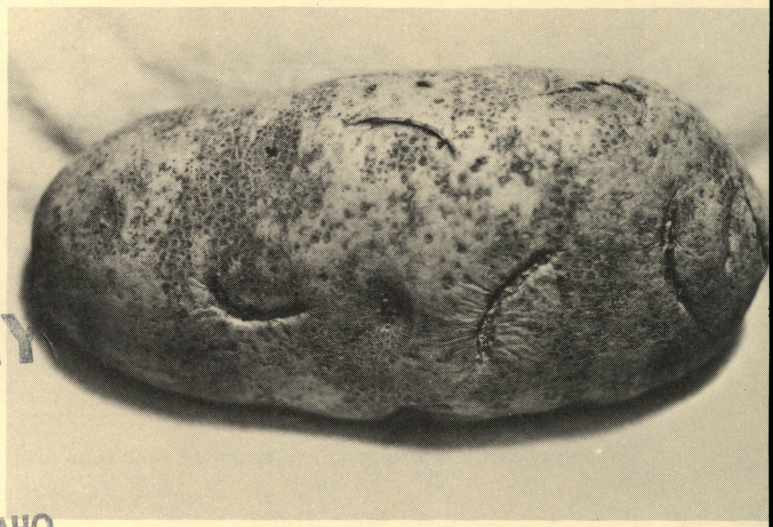
Thumbnail Cracks in Potatoes



What Causes Them How to Reduce Them

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In recent years, the consumer has become much more critical of the quality of the product that she purchases on the retail market and anything that detracts from the appearance of the product also reduces the sales appeal for the product. One of the defects found to detract from the appearance of various lots of Idaho grown Russet Burbank potatoes on the retail market is the "thumbnail crack."

Various factors have been suggested as the cause of "thumbnail cracks" such as: a rapid change in temperature or humidity, the drying out of the skin or periderm, and rough handling causing bruising or injury to the tubers. It was the objective of this study to determine the cause of thumbnail cracks and devise a means to reduce or eliminate their occurrence on potato tubers.

Materials and Methods

Potato tubers from seven different lots or sources were selected for this study. Approximately 500 equal sized tubers from each lot were carefully selected, washed and left untouched for ten days. After the ten days, each injury on each tuber was marked with India ink. The marked tubers were then placed in rigid boxes with approximately 250 tubers placed in a 40 degree storage room and the other 250 tubers were placed in another storage room (58 degrees or 66 degrees) for a period of two weeks or longer. Then they again were examined carefully for injury. The tubers showing no additional injuries were used in the subsequent trials.

Trial 1 consisted of running one half of the 40 degree lot of tubers across a grader consisting of a hopper, an elevator, a sizer and a grading table. Then they went into a container. One box containing one half the graded tubers was held in the storage building at 40 degrees and 85 percent relative humidity. The other half was placed in the laboratory at approximately 72 degrees and 50 percent relative humidity. The remaining half of the tubers which had not been graded were very carefully hand separated into two rigid boxes and placed along side the graded tubers of the same lot. These tubers acted as controls for the graded lots.

The tubers held at 58 degrees were similarly divided — one half graded, one half not graded, and one half of the graded lot and one half of the ungraded lot stored at 72 degrees and the other half of each stored at 40 degrees. The tubers from each lot were carefully examined for injury — especially thumbnail cracks — at various times after grading.

To obtain a single figure that could be used for analysis, the length and width of each crack on each tuber was recorded in terms of an index. An index unit of one indicated a crack 1/8 of an inch long and 1/32 of an inch wide. For example, if a crack were 1/2 inch long and 1/16 inch wide, its index was 8.

The non-graded tubers showed no thumbnail cracks at all, and after a period of two weeks were transferred to another temperature to determine if temperature alone, without handling, would cause cracks to appear. Various lots of these non-graded tubers were transferred from one temperature to another as many as five times and still no cracks appeared.

The remainder of the trials in the study were conducted approximately the same way, using various pulp temperatures at grading time. Also included in this study was a trial to determine the amount of handling required to cause injury, and a trial to determine the effect of grading the tubers when the skin was wet(washing) vs. grading and handling when the tubers were dry.

To determine the amount of handling required to cause cracks, some lots were gently transferred (poured) from one container to another and then compared to the amount of cracks caused by running them over a grader.

To compare the injury caused by handling wet potatoes vs. handling dry potatoes, half of each of several lots was run over the washer-grader equipment in a dry condition and the other half run over the same equipment with the water turned on after first being wetted.

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Table 1. Summary Table Showing the Effect of a Change In Temperature and Humidity on the Formation of Thumbnail Cracks in Russet Burbank Potato Tubers.

Handling Procedure	Pulp Temp.	Stor. Temp.	Stor. R. H.	No. Tubers Examined	% Tubers With Cracks	Index* Per Tuber
None	38	40	85	294	0	0
None	38	66	75	294	0	0
None	38	72	50	294	0	0
None	58	40	85	72	0	0
None	58	66	75	72	0	0
None	58	72	50	72	0	0
None	72	40	85	294	0	0
None	72	66	75	294	0	0
None	72	72	50	294	0	0
None	49	66	75	76	0	0
None	32	40	85	52	0	0
None	33	66	75	45	0	0

*An injury index unit of one = 1crack 1/8 inch long and 1/32 inch (or less) in width.

Results

TEMPERATURE CHANGE

Table I shows the effect of a change in temperature and humidity, without handling, on the formation of thumbnail cracks in Russet Burbank potato tubers. These data show that regardless of the pulp temperature, and regardless of the subsequent storage temperature or the subsequent storage relative humidity, if the tubers were not handled or graded, no cracks appeared on the tubers. This shows that for thumbnail cracks to appear on a tuber, some type of handling operation has to take place.

PULP TEMPERATURE

Table 2 shows the effect of pulp temperature at the time of handling on the formation of thumbnail cracks. These data show that the lower the pulp temperature when any given lot of potatoes is handled, the greater is the percentage of tubers having cracks and the higher the injury index per tuber. In lots where the mean pulp temperature was 36 degrees, 99.1 percent of all of the tubers formed cracks with a mean injury index of 47.0. Only 95.8 percent of the tubers from companion lots with a mean pulp temperature of 49 degrees formed cracks and they had an injury index of only 39.0.

Of course, the number and size of the cracks varied as the source and previous handling varied among lots. But within each individual lot, the colder the tubers were handled, the greater was the amount of injury. This indicates that regardless of the susceptibility of a particular lot of tubers to injury, the amount and severity of injury can be reduced if the tubers in that lot are warmed before handling.

Table 2. Effect of Pulp Temperature at Time of Handling on Formation of Thumbnail Cracks.

Mean Pulp Temp.	No. Tubers Examined	% Tubers With Cracks	Injury Index Per Tuber
36°	211	99.1	47.0
49°	211	95.8	39.0

STORAGE ENVIRONMENT.

The environmental conditions under which the potatoes were stored after handling also had an effect upon the number and seriousness of the thumbnail cracks formed. Table 3 shows that when the tubers were subjected to a storage temperature of 66 degrees and 75 percent relative humidity, 98.5 percent of the tubers formed thumbnail cracks with an injury index per tuber of 52.1. By comparison, when the tubers of the same lot were stored at 40 degrees with a relative humidity of 85 percent, some 97.6 percent of the tubers still showed cracks, but the injury index per tuber was only 30.4.

In another trial, one half of another lot was graded and then placed in a room at 72 degrees and 50 percent relative humidity. Of these, 97.2 percent formed cracks with an injury index of 22.3 per tuber. The other half of this same lot was stored at 40 degrees and 85 percent relative humidity. Even though 94.2 percent of the tubers still showed some cracks, the injury index was only 13.5 per tuber.

Because the storage recommendations have changed in the last few years, a third trial was set up to compare the new storage recommendations (45 degree temperature and 95 percent or more relative humidity) with the old storage conditions, especially with relation to relative humidity. In this trial, three storage humidities and two storage temperatures were used. One lot was stored at 70 degrees and 65 percent relative humidity, a second lot at 45 degrees and 85 percent relative humidity, and a third lot at the newly recommended environment of 45 degree and 95+ percent relative humidity.

The results of this trial showed that after grading and storing for 10 days at 70 degrees and 65 percent relative humidity, 98 percent of the tubers formed cracks with a mean injury index per tuber of 13.3. When the storage temperature was 45 degrees and the relative humidity was 85 percent, 90 percent of the tubers formed cracks but with an injury index per tuber of 8.2. When the now recommended temperature of 45 degrees and relative humidity of 95 percent or higher was used, still 90 percent of the tubers formed cracks, but the mean injury index per tuber was only 7.2.

These data show that the storage environment under which the tubers are placed after they have been handled

Table 3. Effect of Storage Humidity on Formation of Thumbnail Cracks.

Lot No.	Storage Temperature	Storage Humidity	No. Tubers Examined	% Tubers With Cracks	Injury Index Per Tuber
1	72	50	72	97.2	22.3
1	40	85	74	94.2	13.5
2,3,4	66	75	303	98.5	52.1
2,3,4	40	85	302	97.6	34.4
7	70	65	50	98.0	13.3
7	45	85	50	90.0	8.2
7	45	95	50	90.0	7.2

has a great effect upon the formation or prevalence of the number and severity of thumbnail cracks on the tubers. The higher the storage temperature and the lower the storage relative humidity for any given lot of tubers, the greater the percent of tubers with cracks and the greater the injury index per tuber.

Washing (Dryness or Wetness of Skin)

Another factor having considerable effect upon the number and size of cracks produced was the dryness or wetness of the skin (periderm) of the tubers at the time they were run across the grading table. Wet tubers had fewer and less severe cracks than tubers of the same lots run over the same equipment in a dry condition. This wet condition was achieved by dipping or soaking the tubers for a few minutes. While the skins were still wet, they were dumped into the hopper (to simulate fluming) and run over the washer-grader with the water in the washer turned on.

Table four shows that when the tubers were wet and then run across the equipment, only 87.2 percent of the tubers formed cracks with a mean injury index per tuber of 23.5 In comparison to this, when the other half of these same lots of potatoes were run across the same equipment with the periderm in a dry condition and no water being turned on in the washer, 99.4 percent of all of the tubers showed cracks with a mean injury index per tuber of 61.9. This means that the tubers run over the equipment in a dry condition had an injury index over 2 1/2 times greater than tubers of the same source run over the same equipment when wet.

Table 4. Effect of Wetting the Periderm (Skin) and Washing on Formation of Thumbnail Cracks.

	No. Tubers	% Tubers With Cracks	Injury Index Per Tuber
Wet [1]	235	87.2	23.5
Dry [2]	232	99.4	61.9

[1] Wet means that the tubers were wet before being dumped into the hopper (to simulate fluming) then run over the grader with the water in the washer turned on.

[2] Dry means that the tubers were dry when dumped into the hopper and run over the grader without any water being turned on (to simulate a "dry" pack operation).

Handling Procedure

The amount of handling received by the potatoes had the greatest effect upon the number and seriousness of the thumbnail cracks formed. Table five shows that when the potatoes were not handled in any way, no thumbnail cracks appeared. Even when the tubers were gently transferred or poured from one container to another, thumbnail cracks began to appear on the tubers. Of 347 tubers examined, 16.9 percent showed cracks after being transferred or poured from one container to another with a mean injury index of 3.2 per tuber. Amount of handling was increased by running another portion of these same lots of tubers over the grading equipment, 97.3 percent of all of the tubers showed cracks with a mean injury index per tuber of 41.2.

These data show that with no handling there were no cracks, gentle handling resulted in slightly less than 17 percent of the tubers showing cracks, and with rougher handling slightly over 97 percent of the tubers showed cracks. These data also show that each tuber showing cracks in the gently handled lot had only one crack less than 1/2 inch in length and less than 1/32 inch wide. On the other hand, the graded lot had about 2 cracks per tuber from 1 to 1 1/4 inches long and about 1/16 inch wide. This shows that the more and rougher the tubers were handled, the greater the amount of thumbnail cracks which appeared on the tubers and the more serious these cracks became.

Table 5. Effect of Handling Procedure on the Formation of Thumbnail Cracks.

Handling Procedure	No. Tubers Examined	Mean % Tubers With Cracks	Mean Injury Index Per Tuber
None	348	0	0
Transferred [1]	347	16.9	3.2
Graded [2]	349	97.3	41.2

[1] Transferred is the gentle pouring of tubers from one container to another.

[2] Graded means the tubers were dumped into the hopper and run across the elevator, sizer, and grading table into a container at the other end.

Summary

These data show that handling is the most important factor in causing "thumbnail cracks" to appear, but after the tubers have been predisposed to injury — handled by any piece of equipment — the environmental conditions under which the tubers are stored is the factor which determines the extent and the size of development of the thumbnail cracks. Warm, dry conditions cause these cracks to become more apparent more rapidly and also causes them to become much larger and more severe than high humidity conditions. Cool high humidity conditions tend to reduce the number and severity of thumbnail cracks which do appear.

These data also show that temperature change alone without any handling does not cause the formation of thumbnail cracks. As the amount and roughness of handling increase, the amount and severity of thumbnail cracks increase.

Therefore, to reduce the number and severity of thumbnail cracks on Russet Burbank potato tubers; 1. The tubers should be handled as little and as gently as possible. 2. They should be warmed up before they are handled. 3. They should be wet when graded, and 4. After grading, the tubers should be placed in a storage environment containing a high humidity (95 percent or more).

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