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Bruises of Potato Tubers

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Potato tubers are harvested and placed in storage. When taken out of storage, their skin is partially peeled, has round, dark blotches, or has black spots just beneath the skin. Did disease cause these? This publication reviews the different types of tuber bruising and their causes.

There are five types of potato bruises: cuts or slices, skinning, shatter, pressure, and blackspot. The causes vary, but all result from physical contact with another object, not disease. Sometimes, tubers exhibit eating damage from insects such as wireworms, flea beetles, and white grubs, but this is considered feeding injury, not tuber bruising. Common scab on tubers is also a feeding injury or blemish (see NebGuide G1940, *Common Scab of Potatoes*). These injuries are not discussed in this publication.

The most common disruption of potatoes is skin breakage or external bruising. The three types of external bruising are slicing or cutting, skinning, and shattering. External bruising undergoes wound healing (see NebGuide G2273, *Potato Tuber Wound Healing*). Bruising affects potato quality for markets such as fresh, processing, and seed. Breaks in the skin can provide an entry point for pathogens such as those that cause wet rots (see NebGuide G2203, *Wet Rots of Potato in Storage*). Tuber shrinkage is associated with water loss through the broken skin surface. In potato processing for chips and fries, peeling often results in a reduction in product yield, and blemishes can reduce marketability as fresh produce.

Cuts

Cuts *(Figure 1)* result from a sharp object such as a metal edge slicing into the potato skin or even slicing through the whole tuber, such as when preparing seed-pieces for planting. Depending on the sharpness of the object, it can result in a clean slice through the native periderm, the outer layer of tissue, with little, if any, tearing. During harvest, cuts occur primarily during the digging and lifting process. The most traumatic occurrence of cuts is during seed-piece preparation. To avoid this, the blade of the digger should be below the tubers with no sharp edges sticking out into the flow of the potatoes. With time and other factors, even severe cuts will heal; that is, form a new periderm.

Skinning

A very common type of bruising is skinning, which involves a tearing of the periderm resulting from impacts with blunt objects or the sides of harvest and piling equipment *(Figure 2)*. Skinned areas turn dark after a short time, making tuber appearance unacceptable, and as mentioned

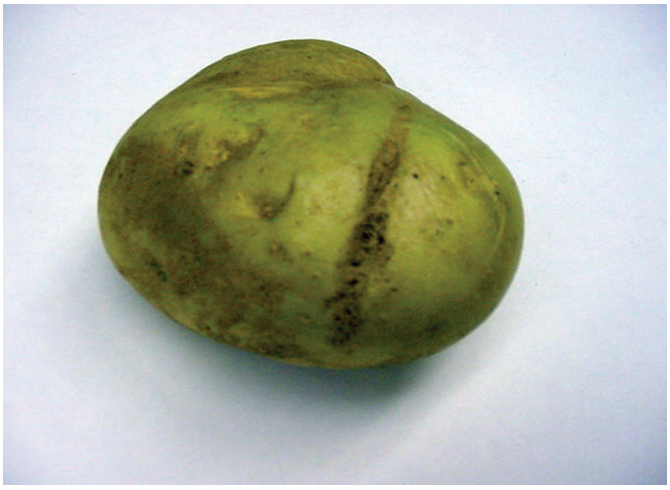

Figure 1. Slice or cut through tuber skin.

Figure 2. Skinning of tuber skin.

Figure 3. Shatter of skin tuber.

previously in this publication, pathogens can enter through these abrasions, and water can be lost from the tuber as well. This type of abrasion (scrapes, rubs, scuffs), sometimes called feathering, is key to understanding the wound healing process at the tissue and cellular level. Cultivars differ in their ability to heal the skinned layer.

The principle factor affecting skinning, besides collisions, is the maturity of the tuber at harvest. Tubers that have been in the ground for about two weeks after vine death are more mature. As a result, they are less susceptibility to skinning (that is, their level of skin set) and better able to heal the abrasion (wound healing). Skinning is a result of poor adherence of the skin to the storage cells (parenchyma) below it. Therefore, the skin is more easily ripped or sheared off. Chemical, mechanical, and vine desiccation caused by freezing temperatures will start the process of skin set, resulting in greater resistance to skin shear and to skinning.

Shatter

The third type of external bruise is shatter, which is the splitting of the skin caused by a hard impact such as a drop greater than 6 inches during the moving and piling operation. Shatter bruising appears as small cracks radiating from the point of impact *(Figure 3)* and also can be caused by some tuber diseases such as ring rot. Skin shattering is directly proportional to tuber hydration. Over-hydrated tubers, often harvested from wet soils, are especially susceptible to shatter. Harvesting and handling tubers below 50° F allow tubers to shatter more easily. Tubers with high specific gravity or greater dry matter content also seem to be more susceptible to shatter. Potato tubers with this bruise are readily prone to tuber early blight as well as to dry rot and soft rot.

Pressure

Pressure bruising is another external bruise that occurs during storage when tubers press against each other in a pile. A pressure bruise appears as a depressed, dark, softened, and circular area on the tuber surface *(Figure 4)*. It may be as small as ¼ inch in diameter to as large as 2 inches. The depression may be as much as a ½ inch deep. (At home, you may have noticed apples with pressure bruising since the symptoms are very evident.) Once formed, a pressure bruise enlarges over time. When the center of the bruise dries, it may collapse and form a cavity. Obviously, a pressure bruise markedly reduces marketability and must be sorted out when tubers leave storage. However, as cells at the surface break down in storage, an entry portal for pathogens develops, and tuber rots may develop in the pile.

Pressure bruises occur on tubers at the bottom of a pile

Figure 4. Pressure bruise on tubers in storage.

and result from the weight of tubers above. Do not pile tubers higher than 18 feet. Bruising is aggravated under conditions of low relative humidity. Storage humidity should be greater than 90 percent RH. Dehydrated tubers are especially susceptible. Tuber water loss is fairly common in immature tubers, wounded tubers, and tubers harvested from soil with low moisture. Potato cultivars that have tubers with low solids, such as most red-skinned varieties, have the greatest risk. The condition is a phenolic reaction in the periderm (tuber skin cells) that also produces ethylene gas. Ethylene, a growth hormone, promotes further cell wall breakdown in an auto-catalytic reaction, thereby making the condition increasingly worse.

Internal Blackspot (IBS)

In addition to impact-caused, external bruising, there is an impact-caused internal bruise that is not visible on the tuber surface. Called internal blackspot (IBS) or just blackspot, it occurs under the skin surface and can only be seen by removing the skin or cutting into the tuber where the discoloration exists. IBS appears as a small, dark, oval area just under the skin *(Figure 5)*. When potatoes are fried, these dark spots appear as a deep dark color near the edge of the tuber surface. For instance in a potato chip, IBS areas appear along the chip's rim *(Figure 6)*.

IBS forms as a result of an impact of the tuber against a hard surface such as the sides of the harvester or piler. The discoloration under the skin appears one to two days after the impact. As with pressure bruising, it results from a phenolic reaction in the wounded cells. Cells collapse; ethylene is released; and further cell wall breakdown occurs, resulting in more cell death. The dark discoloration identifying IBS and pressure bruising is caused by melanin, a pigment formed in the phenolic reaction. (Note: This is the same pigment that darkens human skin). As with pressure bruising, susceptibility to IBS is related to tuber dehydration or firmness. Tuber firmness may be inversely related to the amount of dry matter in the tuber, thereby making tubers with higher solids more susceptible to IBS than those with lower solids. Tubers should be harvested when their internal temperature is above 45° F and less than 65° F. Also, harvesting when the soil is moist helps minimize the occurrence of damage.

Figure 5. Internal Blackspot (IBS) below tuber skin.

Figure 6. Internal Blackspot as seen on a potato chip.

Testing for Bruising

Catechol Test

The most common method of testing for bruises used by growers and processors is the catechol test, which primarily detects external bruises: skinning, shatter, and depth of cuts. It does not detect IBS. Catechol (1,2 dihydroxy benzine) reacts with wound enzymes, turning purple to dark red. It is commercially available.

STEPS IN THIS PROCEDURE:

1. Collect a 10-tuber sample, three to five pounds, and wash off all soil and debris.
2. Immerse tubers for one to five minutes in 1.5 percent catechol or 2 ounces of catechol per gallon of water with a bit of soap, detergent, or nonionic surfactant to break the water tension.
3. Drain and let stand for one to 10 minutes.

Figure 7. Tetrazolium test, Ranger Russet after peeling.

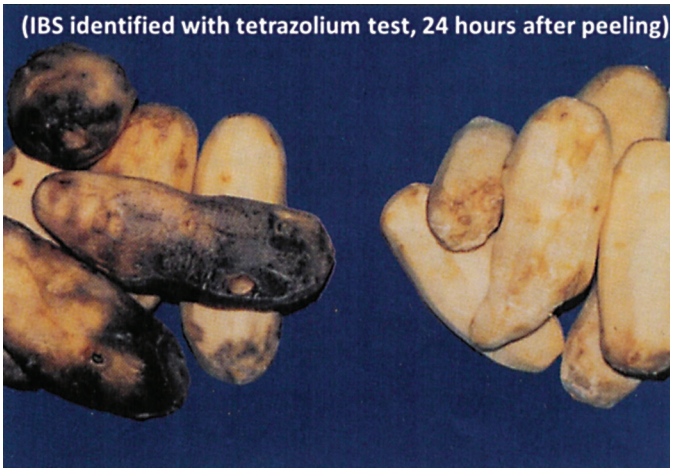

Figure 8. IBS resistance: conventional (right), GMO (left).

Purple or dark red areas indicate bruises. The severity is estimated by the number of strokes it takes a potato peeler to get below the discoloration. One stroke indicates a surface bruise, probably skinning or slight shatter. Two strokes indicate a shallow bruise, shatter, deep abrasion, or slight cut. If more than two strokes are needed to remove the catechol stain, the bruise is deep and serious.

Tetrazolium Test

A specific test for internal blackspot (IBS) is called the tetrazolium test. Tetrazolium (TTC or triphenyl tetrazolium chloride) is commercially available. A common product name is Tetrazolium Blue.

STEPS IN THIS PROCEDURE:

1. Collect a sample of tubers and wash them to remove soil and debris.
2. Peel the tubers slightly, then place them in 0.5 to 1 percent 2,3,5-tetrazolium chloride for 30 to 90 minutes.

Bruises will appear as dark pinkish areas in a matter of minutes *(Figure 7)*. The staining is most pronounced when this test is done under sunlight and when the tetrazolium is dissolved in water warmed to room temperature (70° F). Tetrazolium is toxic to animals and humans so the potatoes and leftover solution must be disposed of safely.

IBS Resistance in the Future?

Can genetic modification of potato varieties make tubers resistant to IBS? In the 1990s, the biotechnology company NatureMark, no longer in business, genetically modified several varieties, including Ranger Russet, to be bruise resistant. The company was very successful in incorporating bruise resistance as can be seen in the Ranger Russet in *Figure 8*. Ranger Russet tubers were purposely impacted to produce IBS. The tubers on the right are the standard variety and those on the left are the GMO-modified tubers. One day after peeling, the tubers were tested with tetrazolium for bruising. These GMO varieties, such 'New Leaf', are not available. GMO technology has improved many quality features of potato such as a vitamin A potato type, but it, too, is not available. Improved potato varieties may become available in the future when GMO technology becomes more accepted by the public.

This publication has been peer reviewed.

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