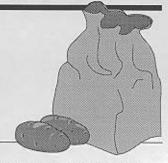
POTATO EYES

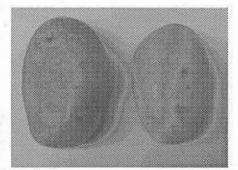
Vol. 12, Issue 4, September 2000 . Alexander D. Pavlista, Extension Potato Specialist



Green Potatoes:The Problem

Questions are often asked concerning buying and eating potatoes that have a green skin (picture 1) and may be green inside (picture 2). Potato tubers, like vines, turn green when exposed to light. There are two facets to the question of green potatoes. One is the market appearance of potatoes and the other is health concerns dealing with

eating a green
potato. These are
two separate though
related issues.
Marketing
appearance
problems are
associated directly
with greenness which
is due to chlorophyll
biosynthesis. Health
concerns are due to
a parallel
biosynthesis of a



Picture 1. Yukon Gold tuber: left exposed to fluorescent light, right was not.

glycoalkaloid called *solanine*. First, however, what causes greening in potato?

Greening

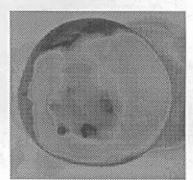
Exposure of potato tubers to light either in the field, in storage, on the store shelf, or at home, will induce the formation of a green pigmentation on the surface of the potato. This is called "greening" and indicates the formation of chlorophyll. This pigment is completely safe and is found in all plants, lettuce, spinach etc. It is primarily found in leaves and is responsible for a plant's ability to make food, photosynthesis. The US Standards consider greening of 5% of a lot of tubers as 'damaging' and the lot will be graded down. Therefore, green potatoes are graded out before reaching the retail market.

Greening is strongly affected by three light factors: quality, duration, and intensity. Chlorophyll is green because it reflects green light while absorbing red-yellow and blue light. Chlorophyll formation is most efficient under red-yellow light. Under green light, there is practically no potato greening and there is little under blue or ultra-violet lights. Day-light fluorescent lights are quite capable of inducing greening, more so than incandescent light. As a

rule, fluorescent light above 75 foot-candles exposure at room temperature, 68F, for three to five days will start the

greening process. Light intensity may be as low as 5 foot-candles and light durations as short as 12 hours can cause greening of a few potato varieties such as Kennebec.

A key fourth factor is temperature during light exposure. This is important because greening is an enzymatic response and enzyme activity is increased with increasing



Picture 2. Red Norland tuber exposed to fluorescent lighting.

temperature. There is NO greening when temperature is less than 40F, refrigeration temperature, and is most rapid at 68F, room temperature. The difference in greening at 50 versus 68F is how long it takes to fully green.

Concerns

Of itself, chlorophyll is not a health concern, it is harmless and tasteless. BUT, in potato tubers, it is like the "canary in the mine shaft." The green indicates an increase in the presence of glycoalkaloids, especially, in potato, the substance "solanine" (see structure). When the potato

greens, solanine increases to potentially dangerous levels. Increased solanine levels are responsible for the bitter

potatoes after being cooked. Solanine biosynthesis occurs parallel but independent of chlorophyll biosynthesis; each can occur without the other. Unlike chlorophyll, light is not needed for solanine formation but is substantially promoted by it. The formation of solanine in potato is localized to the skin, usually no deeper than an eight of an inch (3 mm). In processed potatoes such as chips and fries, there is little hazard since peels are removed. It also needs to be strongly emphasized that potato breeding programs have resulted in the commercial release of only potato lines with very low levels of solanine.

Continued from page 1

Green Potatoes: The Problem

[It also needs to be noted that all members of the botanical family Solanaceae produce glycoalkaloid toxins, not just potato. Two common examples are tomatine from tomato and nicotine from tobacco. Some members of this family are historically notorious such as belladonna and deadly nightshade.]

Light contains ultra-violet radiation as well as visible rays. Ultra-violet and visible light in the blue-violet region promotes the formation of glycoalkaloids, steriod-like compounds, and, for potatoes, most notably "solanine" in tubers. When tubers are exposed, the solanin content in the peel may increase as much as ten times. Toxic levels for people are about one-hundredth of an ounce for 200-pound person. This 200-lb person would need to eat about 20 lb of normal potatoes in a day to reach this level. But, with UV light-exposed tubers in which solanin had increased ten-fold, only 2 lb could be dangerous. A large baked potato frequently weighs close to a pound but common sizes are six to 11 ounces in restaurants. Potatoes containing more than 0.1% solanine (.01 oz/10 oz potato) are considered unfit for eating. Cooked potatoes cannot turn green nor produce solanine because the enzyme mechanism for their production is destroyed by heating at cooking temperatures. But, note the chlorophyll and solanine already produced before cooking will remain after cooking.



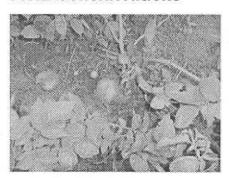


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Green Potatoes:The Solution

The green indicates an increase in glycoalkaloids. When the potato is green, chlorophyll and solanine levels dramatically increase. Chlorophyll's presence results in an appearance undesirable by consumers and solanine's increase may result in a health hazard. Greening is the result of exposure to light and this can occur in the field when potato tubers poke out of the ground. It can also occur in potato storage cellars, on the store shelf and at home on the counter. Since this can be a major marketing and retailing problem, how can greening be prevented or inhibited. The bottom-line is AVOID LIGHT.

Field Considerations



Picture 3. Russet Norkotah tuber sticking out of ground and turning green.

Many factors play a role in greening, 'sunburn,' of potato tubers in the field. Exposure to light in the field occurs when potato tubers protrude from the ground (picture 3). Sometimes associated with light exposure in the field is heat necrosis, a hollowing of the center of the tuber caused by exposure to high temperatures (picture 4). Therefore, maintaining a sufficient soil cover above the potato seed piece and keeping a wide enough hill for new tubers to expand underground are absolutely essential.

- Choose potato varieties that set tubers deeper not shallow. But, if a shallow-setting variety such as Russet Norkotah is grown, make the hills high. Plant deep; six inches (15 cm) is a common recommendation.
- Although fertilization does not directly affect solanine content, excessive and late application of nitrogen can result in higher solanine content due to its affect on growth and maturity.
- Immature tubers contain higher levels of solanine than mature tubers.
 Therefore, don't harvest too early unless planting was early. Vine desiccate and allow tubers to mature before harvesting.
- The ideal hill structure is trapezoidal giving a wide and flat cropping row. This gives room for the new tubers to grow without sticking out.
- Avoid planting on ridges where rows can be exposed to dry soil conditions and wind which may erode or blow-off the row



Picture 4. Internal heat necrosis in Russet Norkotah tuber exposed to light at ground surface in July.

- exposing the seed and making the hill to small to cover new tubers. If such an erosion occurs early enough in the season and herbicide application permit it, rehill and build the row back up.
- 6. Drought in itself does not have effect greening but will promote blow-off and will promote ground cracking. During the season, avoid excessive tillage. If the ground cracks during the end of the season, tubers near the surface may be exposed to light penetrating through the cracks. Avoid drying out of the soil especially after vine desiccation. It is often recommended in dry climates to irrigate just before desiccation. Not only will this avoid ground cracks but will make chemical vine desiccating more effective.

Green Potatoes: The Solution

Storage Considerations

Basically, avoid exposing the pile to light. Use low-wattage incandescent light and don't leave it on longer than needed. Once potatoes turn green, it is irreversible. Sort out green potatoes before going to market. Not only will the buyer complain less but the lot grade will be higher.

Don't wash the tubers going into storage. Dirt remaining on potato tubers will offer some protection against exposure to light and greening. Several reports have shown that washed potatoes will green more readily than unwashed.

Retail Considerations

Note all commercial potato varieties grown in No. America a bred to have low levels of solanine. With thin-skinned varieties, whites and yellows, greening is easier to see, but russet and red varieties will also green. As in the field and storage, the key is AVOID LIGHT. Keep potatoes in the dark. Greening usually occurs at the retail level.

- Shut lights off at night over the potatoes, or cover them with burlap sacks or brown paper bags at night.
- Watch for the start of greening and cover displays or bag the potatoes.
- Locate potato displays in sections with low light intensity. Do not locate at front window or on sidewalks.
- Use a canopy or some decorative overhang to lower exposure to direct sunlight.
- Use incandescent light bulbs which release much less ultraviolet light than fluorsecent ones. Do not use spotlights on potato display.
 - 6. Keep them as cool as possible without freezing (below 40F, 4C).
- 7. Package potatoes in dark paper or dark plastic (vented) bags for this reason. Bags with green cellophane for viewing will inhibit greening and not promote solanin formation. Remember plastic bags must be vented else soft and wet rots will break down the tubers in the bag and you'll have "mush."
- Don't keep potatoes wet when displayed under light since wetness may magnify the light intensity on the skin.

Home Considerations

- At home, store the potatoes for short periods in a dark cupboard preferably in a cool part of the house such as a basement.
 - 2. Wash potatoes only before cooking.
- 3. Green areas, especially the peel, may be cut away and cook the rest for safe eating. But, if you have a tendency toward allergies, it's best to throw the whole potato tuber away to be safe. If the potato tastes bitter, throw it away.
- 4. There has been a report that putting potatoes into a 3% dishwasher detergent solution for 30 minutes will protect them from light for 2 to 10 days, depending on the temperature, light intensity, etc.
- Waxes have not shown to be useful in retarding greening and they can promote tuber breakdown as unvented plastic bags can.

Do People Know About Genes?

It's been more than 120 years since Gregor Mendel's pioneering discovery that characteristics are passed from generation to generation in what we call now genes. A recent survey conducted by Hoban and Miller (Eurobarometer) makes one wonder if this message has gotten through to people yet.

True or False?

"Ordinary tomatoes do not contain genes while genetically-modified ones do."

In the U.S., only 45% of the consumer responses correctly identified this statement to be false while 10% thought that it was true; the remaining 45% didn't know. These percentages get even worst when asked to consumers in several European countries. For example, in Germany, 44% of the consumers thought that this statement was true, 29% in France and 22% in the U.K.

True or False?

"By eating a genetically-modified fruit, a person's genes could also be changed."

Only 61% of U.S. consumers realized that this is a false statement while 9% thought it was true and 30% didn't know. The percents of consumers, who thought this erroneous statement was true, were 30% in Germany, 23% in France and 15% in the U.K.

Trend?

Surveys were conducted by the Food marketing Institute on U.S. consumers' willingness to buy produce with altered genes. In February, 1999, 77% of consumers would buy GMO produce to lessen pesticide use; in October of that year, the percent was lowered to 67%. In February, 1999, 62% would buy GMOs if they tasted better or fresher; in October, the percent dropped to 51%.

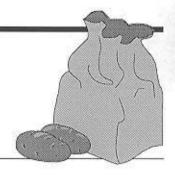
The Nebraska Potato Eyes is on the WWW at: www.panhandle.unl.edu/ peyes.htm



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POTATO EYES



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