G1437 Green Potatoes: The Problems And The Solution

Alexander D. Pavlista
University of Nebraska at Lincoln, apavlista1@unl.edu

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Green Potatoes: the Problem and the Solution

Alexander D. Pavlista, Extension Potato Specialist

This publication outlines how potatoes turn green and form a harmful substance which can cause an allergic reaction, and how to avoid this development.

Green potato tubers are easily identified by their surface coloration. This green coloration ("greening" also called "sunburning") can be as much as a half-inch deep in severe cases. French fries made from green potatoes will have a green end and potato chips will have a green edge. Associated with greening is the formation of a natural chemical that can cause allergic reactions and illness. This publication outlines how potatoes turn green and how to avoid such occurrences.

The Problem

Potato tubers, like leaves, turn green after prolonged exposure to light. There are two separate but related issues associated with green potatoes: market appearance and human consumption. Appearance problems are associated directly with the green skin color which is due to *chlorophyll* biosynthesis. Eating concerns are due to the biosynthesis of glycoalkaloids, mainly *"solanine"*, that occurs at the same time as chlorophyll biosynthesis but is not directly related to it. To address these problems, it is important to first understand what causes greening in potatoes.

Greening

Exposure of potato tubers to light in the field, in storage, on the store shelf, or at home will induce the formation of a green pigmentation near the surface of the potato (*Figure 1*). This is called "greening" and indicates the formation of chlorophyll. This process is completely safe and occurs in all plants. Chlorophyll is primarily found in leaves and is responsible for a plant's ability to make food through photosynthesis. The "United States Standards for Grades of Potatoes" (issued by the U.S. Department of Agriculture) considers greening of over 5 percent of a potato tuber as "damaging" and the lot will be graded below US Grade #1. Therefore, most green potatoes usually are removed before reaching the retail market.

Figure 1. Green coloration near the potato surface.

Greening is strongly affected by the cumulative effects of light 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, practically no potato greening occurs and little occurs under blue or ultra-violet lights. Fluorescent lights induce more greening than incandescent lights. As a rule, fluorescent light above 75 foot-candles exposure at room temperature (68°F) for three to five days will start the greening

> A foot-candle is the intensity of light from a candle held one foot away or one lumen/sq. foot. Sunlight is about 10,000 foot-candles; adequate lighting for steady reading is around 10 foot-candles.

process; however, light intensity 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. This is related to skin thickness and color.

The temperature during light exposure is a key factor since greening is an enzymatic response and enzyme activity increases as temperature increases. There is no greening when the potato temperature is less than refrigeration temperature (40°F) and is most rapid at room temperature (68°F). At higher temperatures greening slows, but potatoes are more prone to decay. Usually grocery store lighting is bright enough to induce greening after a week unless potatoes are kept cool.

Concerns

By itself, chlorophyll is not a health concern. It is harmless and tasteless. In potato tubers, the greening is a sign that there may be an increase in the presence of glycoalkaloids, especially the substance solanine. When the potato greens, solanine increases to potentially high levels. Increased solanine levels are responsible for the bitter taste resulting from a high solanine concentration in 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, with light, glycoalkaloid formation is increased. In potatoes solanine formation is localized near the skin, usually no deeper than one-eighth of an inch (3 mm). In processed potatoes such as chips (*Figure 2*) and fries, little hazard exists since peels are usually removed. Potato breeding programs release only potato varieties that are tested to be safe and contain low levels of solanine.

Note: All members of the botanical family *Solanaceae* — not just potatoes — produce glycoalkaloid toxins. Two common examples are tomatine from tomato and nicotine from tobacco. Some members of this family are historically notorious such as belladonna, now used for treating asthma, and the nightshades.

Ultra-violet radiation as well as visible rays are contained in many light sources such as flourescent bulbs and sunlight. Ultra-violet and visible light in the blue-violet region promotes the formation of glycoalkaloids, steroid-like compounds, and, for potatoes, most notably solanine. When potato tubers are exposed to light, the solanine content in the peel may increase as much as ten times. Toxic levels for people are about one-hundredth of an ounce for a 200-lb person. This 200-lb person would need to eat about 20 lb of normal whole potatoes in a day to reach this level. But, with UV light-exposed whole tubers in which solanine had increased ten-fold, only two pounds could cause a reaction. Potentially high levels for a 100-lb and 50-lb person would be 16 and 8 ounces of a fully green potato, respectively. Removing the green areas, skin and underlying core, the light-induced solanine is removed. A large baked potato frequently weighs about one pound (16 ounces), but common sizes in restaurants are six to 11 ounces. Potatoes containing more than 0.1 percent solanine (.01 oz/10 oz potato) are considered unfit for eating. Cooked potatoes cannot turn green or produce solanine because cooking destroys the enzyme mechanism required for its production; however, any chlorophyll and solanine produced before cooking will remain after cooking *(Figure 2*). A good guide is “if the potato tastes bitter, don’t eat it.”

The Solution

The green color indicates an increase in glycoalkaloids. When the potato is green, chlorophyll and solanine levels dramatically increase. Generally, customers do not desire the presence of chlorophyll and the resulting green color. The parallel increase in solanine may cause a bitter taste and an adverse reaction. As discussed previously, greening results from exposure to light under specific temperature conditions. Exposure to light can occur in the field when potato tubers poke out of the ground (*Figure 3*), on a store shelf or at home on the counter. Since this can be a major marketing and retailing problem, it’s important to prevent or inhibit the amount of greening by avoiding light whenever possible during the handling and storage process.

Home Considerations

Although greening is easier to see with white and yellow

Figure 2. Potato chip with green edge.

Figure 3. Sunburned potatoes.

varieties, russet and red varieties also will green. Avoid buying green potatoes and inform the produce managers if greening is common.

1. 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 before cooking to expose green areas.
3. Cut away green areas, especially the peel, and cook the rest for safe eating. If someone has a tendency toward allergies or allergic reactions, dispose of the whole potato tuber to be safe. If the potato tastes bitter, do not eat it.
4. If potatoes are to be stored in a lighted area for a short time, dip them in a 3 percent dishwasher detergent solution (one ounce or two tablespoons in a quart of water) for 30 minutes prior to storage. This has been reported to protect them for 2 to 10 days, depending on the temperature and light intensity.
5. Waxes are not effective in retarding greening and may promote tuber breakdown by limiting aeration.

Retail Considerations

All commercial potato varieties grown in North America are bred for low levels of solanine. The key is *to avoid light*. Keep potatoes in the dark. Greening of commercial potatoes usually occurs at the retail level.

1. Shut lights off at night over the potatoes, or cover the potatoes with burlap or brown paper sacks.
2. Watch for the start of greening and cover displays or bag the potatoes.
3. Locate potato displays in sections with low light intensity. Do not locate at front window or on sidewalks.
4. Use a canopy or some decorative overhang to lower exposure to direct artificial light and sunlight.
5. Use incandescent light bulbs; they release much less ultraviolet light than flourescent ones. Ultraviolet increases greening. Do not use spotlights on a potato display.
6. Keep potatoes cool, around 40°F if possible, without freezing.
7. Package potatoes in dark paper or dark plastic bags to avoid light exposure. Bags with green cellophane for viewing will inhibit greening and not promote solanine formation. Remember plastic bags must be vented or soft and wet rots will break down the tubers in the bag and result in "mush."
8. Keep potatoes dry when displayed under light since moisture may magnify the light intensity on the skin.

Field Considerations

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 (*Figure 3*). It's absolutely essential to maintain soil cover over the potato seed piece and keep a wide enough hill for new tubers to expand underground.

1. When possible, choose potato varieties that set tubers deeper rather than shallow. If a shallow-setting variety such as Russet Norkotah is grown, make the hills high and plant deep, six inches (15 cm) is recommended.
2. Fertilization does not directly affect solanine content, but excessive and late application of nitrogen can result in higher solanine content due to its effect on growth and maturity.
3. Immature tubers contain higher levels of solanine than mature tubers. Therefore, don't harvest early unless planting was early. Desiccate vines and allow tubers to mature before harvesting. Due to bruising, harvest should be timed two to three weeks after vine desiccation.
4. The ideal hill structure is trapezoidal (broad base slopping to a narrow top), giving a wide cropping row with a flattened top. This gives room for the new tubers to grow without sticking out.
5. Avoid planting on ridges where rows can be exposed to dry soil conditions and wind which may erode the soil, exposing the seed and making the hill too small to cover new tubers. If such erosion occurs early enough in the season and herbicide application permits, re-hill and re-build the row.
6. Drought in itself does not affect greening but will promote soil erosion, blow-off, and ground cracking. During the season, avoid excessive tillage. If the ground cracks at 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. In dry climates consider an irrigation just before desiccation. This will reduce cracks in the ground and make vine desiccation more effective.

Storage Considerations

Potato storage cellars are dimly lit and cool. Avoid exposing the pile to sunlight. 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 marketing them. 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 offers some protection against exposure to light and greening. Washed potatoes often will green more readily than unwashed potatoes.

With just a few precautions, potatoes will store for a long time, and be ready to eat at your convenience.

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