The Difference Between Waxy and Mealy Potatoes

No doubt you have read that high-starch mealy potatoes, like Russet Burbank, are best for mashing and baking, while low-starch waxy potatoes such as Red Bliss, are best for boiling and making potato salad. Much has been written about why waxy and mealy potatoes perform differently, but not all of it is consistent with the research on the cooking properties of different varieties of potatoes. So let's see what the research tells us.

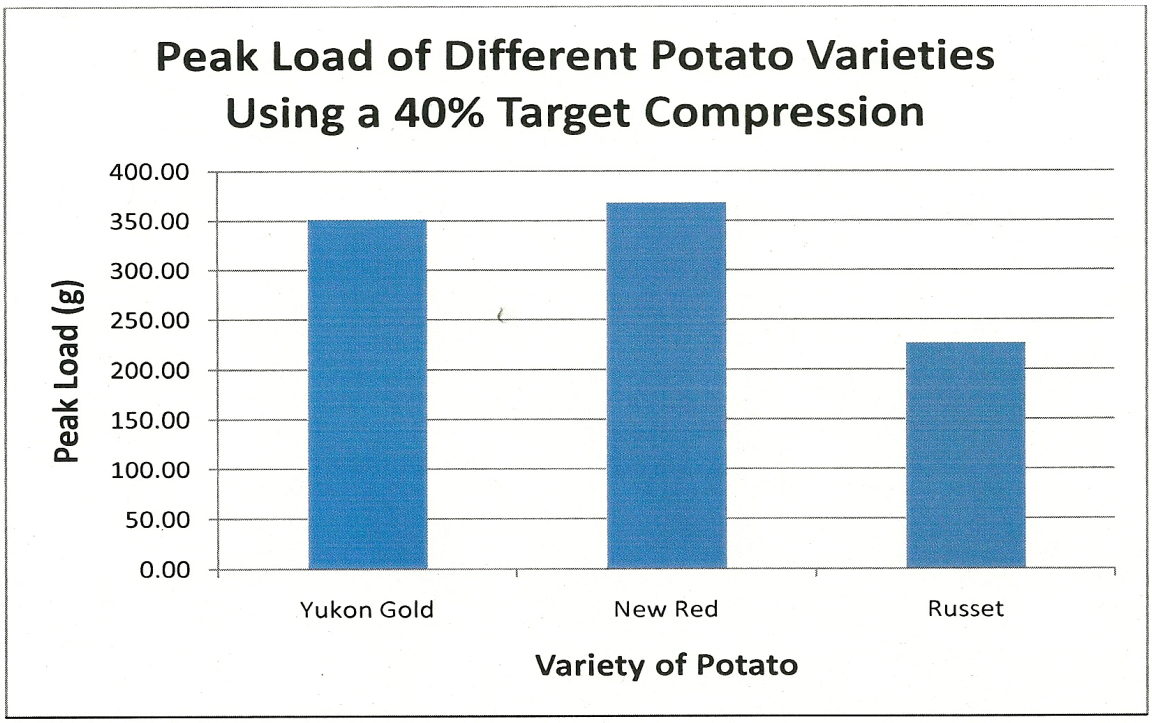
Let's start by defining what we mean by waxy and mealy potatoes. According to Professor Diane McComber (Iowa State University, retired; J. Food Sci. 1988, 53: 1423-1426) sensory panelists describe cooked waxy potatoes as moist, mushy, and smooth, while cooked mealy potatoes are harder, drier, and produce a sensation of particulate matter in the mouth. Waxy potatoes tend to have a thin skin, are less dense, and contain lower levels of starch (about 16% on a wet weight basis) and higher moisture. Mealy potatoes tend to have thicker skins, are denser, and contain more starch (about 22% on a wet weight basis) and less moisture. On a molecular level, the starch in waxy potatoes is composed almost entirely of the large branched molecule called amylopectin, while the starch in mealy potatoes is composed of a mixture of amylopectin (about 74%), and the much smaller linear amylose molecule (about 26%). Both amylopectin and amylose are polysaccharides, which function as storage forms of glucose.

Further research by Professor McComber (J. Agric. Food Chem. 1994, 42: 2433-2439) showed that when high-starch Russet Burbank potatoes were cooked (steamed) the potato cells became "completely engorged with gelatinized starch", in contrast to two varieties of low-starch waxy potatoes (Pontiac and LaSoda), which appeared to be "only 30-50% filled" with swollen starch granules. Using nuclear magnetic resonance spectroscopy (NMR) the higher level of starch granules in Russet Burbank potatoes were observed to absorb more moisture while less of the moisture in the lower-starch waxy potatoes was absorbed by the swollen starch granules leaving more free moisture. This explains why mealy potatoes are perceived as dry while waxy potatoes are characterized as moist. On eating, the waxy potatoes release the loosely held water that is not bound up by the lower level of gelatinized starch.

Interestingly, Professor McComber's research showed in both the waxy and mealy varieties the cells of steamed potatoes were intact and not collapsed when visualized by scanning electron microscopy (SEM). Her research also showed that calcium and magnesium ion concentrations were higher in Russet Burbank potatoes than they were in the Pontiac variety of waxy potatoes. Calcium and magnesium ions are known to strengthen pectin, the polysaccharide that is part of the cell wall structure, and more importantly, acts as a glue to hold the cells together. These observations led Professor McComber to agree with earlier research (Am. Potato J. 1980 57: 141-149), which concluded that the cells of

steamed mealy potatoes resist separation into individual cells, but break “into particulate masses” producing a texture that is less smooth than waxy potatoes.

This research goes a long way to explaining the differences in texture of mealy and waxy potatoes, but it doesn’t entirely explain why they behave differently when cooked. To help shed some light on this question, a student in my 2011 Food Analysis class at Framingham State University, Joseph Bazinet*, undertook a project to measure the cooking differences of three varieties of potatoes using an LFRA Texture Analyzer manufactured by Brookfield Engineering. His research helps to explain some of the cooking differences of waxy and mealy potatoes. For the study we choose high-starch mealy Russet Burbank, low-starch waxy Red Bliss, and intermediate Yukon Gold, which is described as a medium-starch potato with cooking properties in between waxy and mealy potatoes. Small cylinders (1.3 x 2.5 cm) of each variety were removed and cooked in boiling distilled water for ten minutes, then plunged into ice water to stop further cooking. The force (measured as the peak load in grams) to compress each cylinder by 40% was recorded with the Texture Analyzer using a flat disk with a diameter wider than the potato cylinder (numerous conditions were tested before selecting this method as being the most reliable). The results are shown in the figure below (based on nine replicates of each variety).



From these results it is clear that mealy Russet Burbank potatoes required the least amount of force to compress the boiled potato cylinders. Yukon Gold and Red Bliss required similar amounts of force, with perhaps a slightly lower force required for the intermediate Yukon Gold potatoes. These results indicate the cell structure of mealy potatoes is more readily broken down by boiling water, and is

consistent with the observation that mealy potatoes are better suited for mashing and baking. Both waxy Red Bliss, and intermediate Yukon Gold hold their shape when boiled and thus are better suited for use in potato salad. These results also suggest that Yukon Gold potatoes behave more like waxy potatoes. However these results are for only one lot of commercial potatoes, and it is well known there is significant variation in density and starch content even between potatoes of the same variety.

Research from the Agrotechnological Research Institute, Wageningen, The Netherlands, supports our results (J. Agric. Food Chem. 1997, 45: 50-58, and 1686-1693). These researchers found that more pectin was released when mealy potatoes were boiled compared with waxy potatoes. Furthermore, these researchers concluded from transmission electron microscopy (TEM) the release of more pectin from the cooked mealy variety of potatoes resulted in cell wall loosening and increased cell sloughing (most likely clumps of cells as suggested by McComber) compared with waxy potatoes. Again, this is quite consistent with cooked mealy potatoes requiring less force to compress making them better for mashing and baking, but less smooth and moist.

More recent research published by the same group from The Netherlands (J. Agric. Food Chem. 2002, 50: 5082-5088) convincingly showed that the dry matter (DM) content of mealy, waxy, and intermediate potato varieties strongly overrules any cultivar-specific effects on the cooking properties of potatoes, and that DM directly correlated with the starch content of each variety. **Thus, the starch content of a potato variety has the greatest impact on cooking properties.** Mealy potatoes not only contain more starch, but the composition of the starch is different (a mixture of amylose and amylopectin), as mentioned earlier. As a result the starch granules in mealy potatoes begin to gelatinize around 58° C (136° F) while those in waxy potatoes do not begin to gelatinize until about 70° C (158° F) (Reeve, R. M., J. Texture Studies 1970, 1: 247-284). As heat penetrates inside a cooking mealy potato the starch granules swell and gelatinize more rapidly than in waxy potatoes. Combined with the higher content of starch, much greater pressure is exerted within a mealy potato cell as the pectin glue between the cells breaks down with heat, forcing the cells to swell, rupture, separate, and slough off more readily during cooking.

All this research just to understand why Russet potatoes make better mashed potatoes! And we knew this all along!!

*Note: The first picture at the “Photos” tab is my 2011 Food Analysis class. Joseph (Joey) Bazinet is the third from the right. The other students are, left to right, Joshua Kruger, Meaghan O’Dea, Therese Kimbell, Grace Shea, Guilherme (Will) Meira (with cap), and Robert (Rob) Mulligan. All were great students!