Storage Requirements for Dakota Russet Potatoes

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Introduction:

Dakota Russet is a multi-purpose, medium-maturity potato variety released in 2012 from North Dakota State University. It produces attractive long and blocky tubers with a light skin and creamy white flesh. Dakota Russet has low temperature sweetening resistance resulting in excellent French fry color out of storage. In 2022 Dakota Russet was approved for use by McDonald's becoming only one of eight varieties accepted in North America.

Dakota Russet tubers have specific gravities ideal for processing, falling between Ranger Russet and Russet Burbank. Dakota Russet has shown less susceptibility to sugar ends, environmental stresses, and several problematic potato diseases including Verticillium wilt, pink rot, powdery scab, and pythium leak. Dakota Russet also exhibits high yield potential and nitrogen requirements that are approximately 20% less than Russet Burbank, however it does show a greater susceptibility to blackspot bruising. (Hendricks et al. 2022; The Smorgasbord:Dakota Russet 2023)

Methods:

Dakota Russet and Russet Burbank potatoes were field grown at the University of Idaho Kimberly Research and Extension Center in 2020, 2021, and 2022. Following harvest, potatoes were placed in storage and allowed to cure at 55°F and 95% relative humidity for approximately two weeks. The temperature was then decreased at a rate of 0.5°F per day to holding temperatures of 42°F, 45°F, and 48°F. The potatoes were subsequently stored for 9 months at these temperatures.

Methods cont.:

Dormancy

Dormancy length was defined as the number of days after harvest (DAH) until sprout elongation (at least 0.2 inches) occurred in 80% of tubers in the sample. This definition was used because the length of time between initial sprout development (peeping) and sprout elongation varies greatly among potato varieties. Using this definition of dormancy, ten non-treated potatoes (replicated three times) were assessed each month at two storage temperatures (45°F and 48°F) for sprout growth



Fusarium Dry Rot

Because Fusarium dry rot is an important storage disease in potatoes, new varieties are screened for susceptibility to this disease. To provide an entry point for the pathogen, potatoes were first bruised and then inoculated with *Fusarium sambucinum* to evaluate dry rot susceptibility. Results averaged over 3 years indicate that Dakota Russet was less susceptible than Russet Burbank to Fusarium dry rot (Table 1). The percentage of tuber decay due to dry rot in Dakota Russet was 17% with a 56% incidence (potatoes with > 5% decay), compared to 36% decay and 71% incidence for Russet Burbank.

Table 1. Percent decay (severity) and incidence of potatoes with greater than 5% decay of Fusarium dry rot in bruised and inoculated Dakota Russet and Russet Burbank potatoes. Values are means of three storage seasons (2020, 2021, 2022). Values followed by the same letter were not significantly different ($\alpha < 0.05$) within a column.

Cultivar	% Decay	% Incidence (potatoes with >5%
		decay)
Dakota Russet	17 a	56 a
Russet Burbank	36 b	71 b

Weight Loss

Dakota Russet had significantly greater weight loss compared to Russet Burbank at 42 and 48°F, however there was no significant difference

Sugar & Reflectance

Glucose, sucrose, and fry color data were collected each month in storage from three replications of 10 tubers per variety and storage temperature. Glucose and sucrose concentrations were determined using a YSI model 2900 Biochemistry Analyzer and expressed on a percentage fresh weight basis. Fry color analysis was performed concurrently with sugar extraction using the same tubers. Fry color was determined on 10 fry planks (1.2inch x 0.3 inch) per sample after cooking the planks in canola oil at 375°F for 3.5 minutes. Percentage reflectance was read with a Photovolt Reflection Meter Model 577 on the stem and bud ends of each plank. The planks were also scored subjectively for mottling and incidence of sugar ends. Thin, thread-like areas of dark coloration found in the cortex of the fried potato tissue, known as mottling, can occur in some varieties. Each fry plank was subjectively evaluated for mottling on a scale of 1 to 4 where 1 = no mottling, 2 = mild, 3 = moderate, and 4 = severe mottling.

Reflectance readings are presented together with corresponding USDA fry color data. The USDA colors correspond to the reflectance ranges:

Results:

Glucose

Mean glucose concentrations at harvest (10 days after harvest) for Dakota Russet were 0.011% FW, 0.016% FW, and 0.008% FW in 2020, 2021, and 2022, respectively (Fig. 1). The three-year average glucose concentration for R. Burbank was 0.049%, which was four times greater than the mean concentration of 0.012% FW for Dakota Russet.

Glucose concentrations in Dakota Russet during storage were significantly lower than those of Russet Burbank at all three storage temperatures (Fig. 1). Low glucose concentrations in processing potatoes are desirable for producing light-colored French fries throughout long term storage.

- At 48°F storage temperature, glucose concentrations remained below 0.035% FW over the course of 270 days in storage and across three years of trials. Russet Burbank had an average glucose concentration of 0.06% FW across three years of trials.
- At 45°F, glucose concentrations remained below 0.05% FW during the nine-month storage season across the three years of testing. This concentration was low compared to Russet Burbank, which had an average of 0.08 % FW and a peak of 0.1% FW after approximately 100 days in storage.
- At 42°F, glucose concentrations for Dakota Russet remained below 0.1% FW during 2021 and 2022, and for 75% of the storage season in 2020. Potato varieties that maintain glucose concentrations below 0.1% FW at colder storage temperatures are considered cold-sweetening resistant and can be stored at this cooler

between the varieties at 45°F (Table 2).

Table 2. Percent weight loss of Dakota Russet and Russet Burbank tubers after 270 days in storage averaged across three years (2020, 2021, 2022).

Variety	42°F	45°F	48°F	
Dakota Russet	8 a ¹	9 a	10 a	
R. Burbank	6 b	8 a	7 b	

¹Values followed by the same letter are not significantly different.

Bruise susceptibility

During harvest and handling potatoes encounter physical impacts that can result in a blackspot or shatter bruise. Variety susceptibility to two levels of impact (7- and 12-inch drop height of a known weight) was assessed and regardless of drop height, Dakota Russet showed a high incidence of blackspot bruise and a low susceptibility to shatter bruise (Table 3). The severity and depth of the blackspot bruise was higher in Dakota Russet compared to Russet Burbank. Dakota Russet showed a high incidence of blackspot bruise on both the bud and the stem end, whereas Russet Burbank had a higher incidence on the stem end compared to the bud end at the lower drop impact force (Fig. 3).

Table 3. Effects of drop height on blackspot bruise incidence, severity, depth, and shatter bruise incidence for tubers impacted at **7-inch drop** height (2020, 2021, and 2022) and 12-inch drop height (2021 and 2022) of Dakota Russet and Russet Burbank. Values followed by the same letter were not significantly different ($\alpha < 0.05$) for each drop height within a column.

Cultivar	Blackspot bruise incidence (%)	Blackspot bruise severity rating (1-4) ¹	Blackspot bruise depth (mm)	Shatter bruise incidence (%)	
7-inch drop height					
Dakota Russet	94 b	2.7 b	4.8 b	1 a	
Russet					
Burbank	46 a	1.7 a	2.2 a	5 b	
12-inch drop height					
Dakota Russet	97 b	3.2 b	5.7 b	1 a	
Russet					
Burbank	67 a	1.9 a	3.2 a	25 b	

- USDA 1 >44% reflectance
- USDA 2 = 35 to 44% reflectance
- USDA 3 = 26 to 34.9% reflectance
- USDA 4 <25.9% reflectance

Higher reflectance readings indicate a lighter fry color. Fry colors below a USDA 2 are typically unacceptable by the frozen processing industry.

Fusarium dry rot

In studies to evaluate Fusarium dry rot infection, potatoes were first bruised and then inoculated with *Fusarium sambucinum* (50/50 mixture of thiabendazole sensitive to resistant). Following inoculation, potatoes were cured at 55°F and 95% relative humidity for 2 weeks and then stored at 45°F. After approximately 3 months in storage, tubers were evaluated for the percentage of dry rot decay and the incidence of the disease, expressed as the percentage of tubers evaluated having more than 5% decay.

Weight Loss

Samples, averaging 10 pounds per sample, replicated three times, of Dakota Russet and Russet Burbank were weighed monthly and the results averaged over three storage seasons (2020, 2021, 2022).

Bruise

To assess for bruise susceptibility, tubers were impacted soon after harvest using a device that dropped a 100 g steel weight from 7 inch (2020, 2021 and 2022), or 12-inch height (2021 and 2022) to deliver a uniform impact on both the bud and stem ends of a stationary tuber. Pulp temperatures of tubers were 55°F at the time of impact and held for 24 hours at 70°F until impacted areas were peeled and evaluated for blackspot bruise severity, bruise depth, incidence of blackspot bruise, and incidence of shatter bruise. Blackspot bruise severity was rated on the darkest color observed on a scale from 1 to 4: 1= no color, 2=light gray color, not severe but discoloration occurred, 3=dark gray color, severity is moderate, dark but not extreme, 4=dark gray/black color, severity is extreme. Blackspot bruise depth was evaluated by recording the number of slices (1.27 mm per slice) removed by the peeler until no bruise was present.

temperature without the heightened risk of darkening of the finished product that can occur with varieties non- cold sweetening resistant.



Figure 1. Mean tuber glucose concentrations (% FW) averaged across 2020, 2021, and 2022 for Dakota Russet and Russet Burbank at three temperatures over 270 days in storage. The red reference line indicates 0.1% glucose. Varieties that maintain glucose concentrations below this level are generally considered to be cold sweetening resistant. Error bars represent standard error.

Fry color

50

Stem-end reflectance values for Dakota Russet were higher than Russet Burbank indicating a lighter fry color at 42°F, 45°F, and 48°F in all three years of the study (Fig. 2). Fry colors for Dakota Russet were consistently light compared to Russet Burbank and showed little deviation across storage temperatures and between years except for 2020 when Dakota Russet dropped to a USDA 2 midway through the storage season at 42°F. In comparison, Russet Burbank dropped to a USDA 3 by 50 days after harvest at 42°F and maintained a USDA 2 for ¹Blackspot bruise severity was rated on the darkest color observed on a scale from 1 to 4: 1= no color, 2=light gray color, not severe but discoloration occurred, 3=dark gray color, severity is moderate, dark but not extreme, 4=dark gray/black color, severity is extreme



Figure 3. Effect of variety and tuber end on blackspot bruise incidence for A) 7-inch drop height and B) 12-inch drop height. Means are averaged between years: A) 2020, 2021 and 2022 and B) 2021 and 2022. Values followed by the same letter for each graph were not significantly different ($\alpha < 0.05$).

Dormancy

Without sprout inhibitors, dormancy length for Dakota Russet is 60 to 65 days shorter than Russet Burbank (Table 4). The relative shorter dormancy length of Dakota Russet may indicate the need



- most of the storage season at 48°F.
- Storage at 48°F Fry color for Dakota Russet maintained the lightest color throughout the storage season at this temperature. The mean fry color was well above the USDA 1 cutoff and much lighter than the 3-year mean of Russet Burbank, which maintained a USDA 2 except for the second sampling date.
- Storage at 45°F Fry color for Dakota Russet was well above the USDA 1 cutoff for the duration of the storage season compared to the 3-year mean of Russet Burbank, which showed fry colors of USDA 2 and USDA 3 for the entire storage season.
- Storage at 42°F Dakota Russet primarily maintained light fry colors (USDA 1 & 2) compared to the 3-year average for Russet Burbank (USDA 3).

45 F

150 200 250 0

Dakota R.

48 F

150

Days After Harvest

50 100

200 250



Table 4. Mean dormancy length in days after harvest (DAH) across three

 years (2020, 2021, 2022) of Dakota Russet and Russet Burbank tubers at two storage temperatures.

Variety	45°F	48°F
Russet Burbank	190 DAH	178 DAH
Dakota Russet	127 DAH	119 DAH







Figure 2. Percent stem end reflectance (left axis) and associated USDA reflectance values (right axis) of Dakota Russet and Russet Burbank tubers over 270 days in storage at three temperatures. Values were averaged across three years (2020, 2021, 2022). Error bars represent standard error.

Days After Harvest

→ 3-Year Mean → 2020 → 2021 → 2022

50 100

200

150

Days After Harvest

100

250

0

R. Burbank