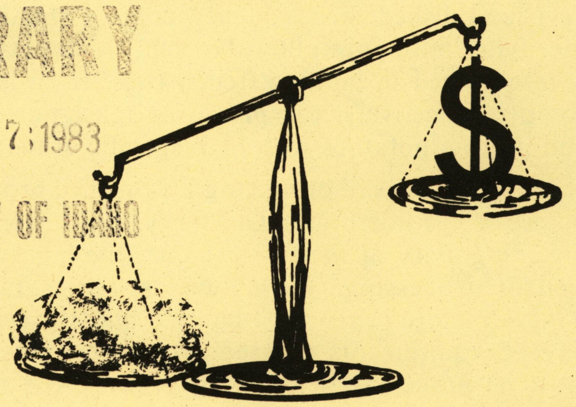
University of Idaho
College of Agriculture

Cooperative Extension Service
Agricultural Experiment Station

Current Information Series No. 609

Specific Gravity of Potatoes



G. D. Kleinschmidt, G. E. Kleinkopf, A. J. Walz and J. C. Zalewski

Specific gravity, as related to potatoes, is an estimate of the solids or dry matter content of the tubers. The actual dry matter content can be determined by ovendrying, but specific gravity is relatively easy to determine and is used as an estimate of tuber quality. The three methods used to measure specific gravity are: (1) weight-in-air/weight-in-water method, (2) use of a hydrometer and (3) use of brine solutions.

The weight-in-air/weight-in-water method is the most common specific gravity measurement. Representative samples are taken at various locations from each field, storage or load of potatoes. Specific gravity is determined by weighing a given amount of potatoes in air and then reweighing them in water. From these two measurements, specific gravity can be calculated by using the following formula:

$$\text{Specific gravity} = \frac{\text{Weight in air}}{\text{Weight in air (minus) weight in water}}$$

$$\text{e.g.} \quad \frac{\text{8.0 pounds}}{\text{8.0 pounds - 0.6 pounds}} = 1.081$$

Total solids of the potatoes can be estimated from the specific gravity determinations as shown in Table 1.

All the potato tubers from one potato plant do not have the same specific gravity, and often one end of a tuber will be different from the other end, as in the case of translucent ends. The weight-in-air/weight-in-water method gives an average specific gravity reading for the sample. Processors use average specific gravity for contract considerations.

Specific Gravity and the Processor

Specific gravity or solid content of raw potatoes affects the processor in three important areas: (1) consumer tastes and preferences, (2) volume purchaser requirements and (3) processing cost. To sell his product, the processor must keep foremost in his mind the consumer's taste and preferences. An interesting taste panel study, conducted by the USDA several years ago, quantifies a well-known fact; consumers generally prefer french fries made from high specific gravity potatoes. The mean palatability of french fries (as measured by mealiness, crispness, lack of oiliness, flavor and tenderness) increases as specific gravity increases. The ideal french fry, as perceived by both consumers and processors, fries light in color, is crisp on the outside and fluffy or mealy on the inside and has a minimum of oiliness. Potatoes with high specific gravity are

Table 1. Relationship of specific gravity to percentage of total solids of potatoes.

Specific gravity	Percent total solids
1.072	18.0
1.074	18.4
1.076	18.8
1.078	19.2
1.080	19.7
1.082	20.1
1.084	20.5
1.086	20.9
1.088	21.4
1.090	21.8
1.092	22.2
1.094	22.7

22

needed to produce such a product. In contrast, french fries produced from low specific gravity potatoes are more oily and have a less desirable water-soaked or mushy texture.

Large volume purchasers of frozen french fries have also recognized consumer preference for the type of french fry produced from high specific gravity potatoes. Most large institutional buyers have established strict quality control standards specifying minimum allowable specific gravity for potatoes used in making french fries. In order to compete effectively, the processor must purchase and process potatoes with high specific gravity.

The economics of producing the finished product is also a consideration. Generally, the lower the specific gravity of the raw product, the higher the cost of processing. With lower specific gravity potatoes, more water must be fried out to meet the buyers' requirements. Consequently, more potatoes must be processed in order to produce the same volume of french fries. The longer fry time results in the potatoes absorbing more undesirable oil. A longer frying time also increases the energy requirements per pound of finished product. Consequently, total processing cost per unit of finished product increases as the raw product's specific gravity decreases.

Factors Affecting Specific Gravity of Field-Grown Potatoes

Specific gravity can be a measurement of relative maturity of the tubers. If the tubers are able to complete the growth cycle without periods of stress, the specific gravity is usually high. Anything which delays or interrupts tuber growth can affect potential yield and decrease quality. Any time the potato becomes stressed, specific gravity or tuber quality may be reduced. The following six factors are more or less uncontrollable from the grower's standpoint:

- **Frost-free Period** — The growing season is defined by the length of this time. Untimely frosts, especially early fall frosts, can prevent adequate time for final tuber growth and can lower both specific gravity and yield.

- **Day Length** — The Russet Burbank variety does not require a specific day length for tuberization and thus is not affected by length of day. However, day length may be a factor for some other potato varieties. In the Pacific Northwest, nearly 90 percent of the commercial potato production is from Russet Burbank, and day length is not an important factor affecting specific gravity and yields.

- **Light Intensity** — The potato is a cool season crop and reaches maximum growth rates at light intensities much less than full sunlight. Under many consecutive overcast days though, reduced plant growth may limit the tuber growth rate. However, in most of our potato growing areas, light intensity is not a critical factor in overall potato growth.

- **Air Temperature** — This factor probably affects potato growth and quality more than any other environmental variable. High temperatures, both day and night, are responsible for the formation of translucent-end potatoes. High temperatures during tuberization may be the most damaging in terms of lower quality tubers. Continued high temperatures, greater than 95°F, will produce lower quality tubers, especially if proper irrigation management is not followed.

- **Wind and Humidity** — These two factors affect water use by the potato crop. High wind may cause moisture stress because of the higher evaporative demand.

- **Soil Temperature** — Although not usually a factor in reduced specific gravity measurements, elevated soil temperatures because of high, exposed hills can be very detrimental to potato quality. High hills warm up quicker, dry out faster and may prevent proper root growth. The top of the potato row should be only high enough to allow for an adequate furrow. Under most situations, the top of the row should be no more than 3 inches above ground level.

High air temperatures before row closure can elevate the soil temperature, but irrigation may help. After row closure, soil temperature remains fairly constant and then is usually not a significant factor in specific gravity reduction.

Factors the Grower Can Control

Management practices and decisions can have a major effect on specific gravity. Approximately 90 percent of the specific gravity problems can be attributed to one or more of the following considerations:

- **Variety** — Early varieties, such as Norgold and Norland, are grown primarily for fresh market and usually have a lower specific gravity than later maturing varieties. Russet Burbank, Butte and Lemhi are mid- to late-season varieties and are higher in specific gravity than earlier maturing varieties. When grown in central and western Idaho, Butte and Lemhi are higher in specific gravity than Russet Burbank. In eastern Idaho, Lemhi is also usually higher in specific gravity than Russet Burbank.

Before selecting any variety, the grower should be aware of its market potential and its fertility, irrigation and handling requirements. Processor contracts may determine the variety to be grown.

• Seed Quality and Seed Piece Size — High quality seed has been shown to produce consistently higher quality crops. A measurable increase in yield occurs as the seed piece size increases up to 3 ounces. The University of Idaho recommends a 2-ounce average size. Small seed pieces usually produce fewer stems and tubers, and the resulting plants may have reduced vigor. The increased cost of high quality seed is usually more than recovered in increased yields and quality and less disease.

• Planting Density — Seed spacing, skips and seed piece decay affect final plant stand or density. The number of plants per acre determine water and nutrient usage rates. Low plant populations may result in higher nutrient levels per plant, delaying tuber bulking. Too many stems could use up the applied nutrients faster than expected and result in reduced yields and quality. Some varieties should be planted at 6-inch spacing and others at a wider spacing based on contract incentives and expected yields. Control of the plant density is essential for optimum nutrient management.

• Irrigation — Prevention of water stress during the growing season will help maintain higher yields and quality. The University of Idaho recommends maintaining 65 percent available moisture until just before vine kill. Optimum yields are obtained when the soil water is kept above 65 percent available moisture throughout the growing season. Periods of water stress, coupled with high air temperatures, are responsible for most of the quality problems in many potato-growing areas, especially at the tuberization period. Irrigation amounts and frequency are two management practices which affect the final external and internal quality of the crop.

• Nutrient Supply — Nitrogen nutrition also can have an effect on the final specific gravity. High nitrogen additions to the Russet Burbank variety can delay the tuber bulking period and consequently reduce potential yield and quality. Many research efforts have shown high nitrogen (higher than University of Idaho recommendations) causes decreased solids. Nutrient additions should reflect UI recommendations or should be based on soil and tissue analysis during the growing season.

• Soil Types and Compaction — Sandy and heavy clay soils produce potatoes with lower specific gravity than medium textured soils. Management practices (cultivation, fertilizer placement, seedbed preparation) that compact the soil can prevent root penetration, adversely affect the potato growth and increase harvesting problems. The potato is a relatively shallow rooted crop and needs good soil texture, moisture and nutrient supply for optimum growth. Cultivation should be minimized, if not eliminated, especially 2 or 3 weeks after emergence.

• Pests (Weeds, Insects, Disease) — Good management practices that minimize pest problems are essential for high yields and high quality. Good controls are available for weed and insect control and should be used to prevent these pests from becoming problems.

Disease prevention is another problem which faces the potato grower. Some varieties may be resistant to one or more of the common potato diseases. With proper nutrition management, the potato crop should be 80 percent completed before disease symptoms become severe. Continued research efforts on the identification and control of potato diseases will help the grower overcome potential problems.

• Days Grown — The grower has some control over the potato growing season. Early planted crops usually have more time to mature and produce higher yields and quality. Since specific gravity is related to maturity, the longer the crop has to grow, the more likely it is to have higher solids. Take advantage of the entire growing season to increase yield and to give tubers the maximum number of days possible in which to grow.

• Timeliness of Operations — Good timing is a measure of the grower's response to needs of the developing crop. These factors include: proper timing of water and nutrient applications; control of pests, planting and harvesting dates; and selection of high quality seed. In short, proper management of the potato crop from spring to fall is essential for high quality yields.

The Authors

G. D. Kleinschmidt is associate professor of plant science and Extension potato specialist, University of Idaho District 3 Office, Twin Falls. G. E. Kleinkopf is associate professor of plant science and plant physiologist, UI Research and Extension Center, Kimberly. A. J. Walz is professor emeritus and Extension potato specialist (retired), UI Southwest R&E Center, Parma. J. C. Zalewski is senior manager of Ag Research, Ore-Ida Foods, Inc., Ontario, Oregon.

SERVING THE STATE

Teaching . . . Research . . . Service . . . this is the three-fold charge of the College of Agriculture at your state Land-Grant institution, the University of Idaho. To fulfill this charge, the College extends its faculty and resources to all parts of the state.

Service . . . The Cooperative Extension Service has offices in 42 of Idaho's 44 counties under the leadership of men and women specially trained to work with agriculture, home economics and youth. The educational programs of these College of Agriculture faculty members are supported cooperatively by county, state and federal funding.

Research . . . Agricultural Research scientists are located at the campus in Moscow, at Research and Extension Centers near Aberdeen, Caldwell, Parma, Tetonia and Twin Falls and at the U. S. Sheep Experiment Station, Dubois and the USDA/ARS Soil and Water Laboratory at Kimberly. Their work includes research on every major agricultural program in Idaho and on economic activities that apply to the state as a whole.

Teaching . . . Centers of College of Agriculture teaching are the University classrooms and laboratories where agriculture students can earn bachelor of science degrees in any of 20 major fields, or work for master's and Ph.D. degrees in their specialties. And beyond these are the variety of workshops and training sessions developed throughout the state for adults and youth by College of Agriculture faculty.

Issued in furtherance of cooperative extension work in agriculture and home economics, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, H. R. Guenthner, Director of Cooperative Extension Service, University of Idaho, Moscow, Idaho 83843. We offer our programs and facilities to all people without regard to race, creed, color, sex or national origin.

2M 11-81

10 cents per copy