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Sprout Production in California

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Sprouts have been used for food since before recorded history. Sprouts vary in texture and taste. Some are spicy (e.g., radish and onions), some are used in Asian foods (e.g., mung bean *[Phaseolus aureus]*), and others are delicate (e.g., alfalfa) and are used in salads and sandwiches to add texture. Vegetable sprouts grown for food are baby plants that are harvested just after germination. Various crop seeds may be sprouted. The most common are adzuki, alfalfa, buckwheat, *Brassica* spp. (broccoli, etc.), cabbage, clover, cress, garbanzo, green peas, lentils, mung bean, radish, rye, sesame, wheat, and triticale. Production practices should provide appropriate germination conditions, moisture, and temperatures that allow for the "harvesting" of the sprouts at their optimal eating quality. Production practices should also allow for efficient cleaning and packaging of sprouts.

VARIETIES

Mung bean seed are used to produce bean sprouts; some soybeans and adzuki beans are also used to produce bean sprouts. The preferred varieties are those that have smaller-sized seed. With small seed, the cotyledons and seed coats are less objectionable or are more easily removed from the finished product. The smallest-seeded varieties of mung bean are Oklahoma 12 and Oriental; larger-seeded types are Jumbo and Berken. Any small-seeded adzuki may be used for sprouts; a variety called Chinese Red Adzuki is sometimes substituted for adzuki bean even though it is not a true adzuki bean.

MISCELLANEOUS SPROUTS

Sprout production and use has increased dramatically over the last 5 years. A wide variety of seeds are used, including alfalfa, buckwheat, chickpeas (garbanzo), cress, lentils, peas, radish, rye, and wheat, but the market primarily handles mung, radish, and cress sprouts, and mixes of these. In general, sprouting requirements remain the same for the different varieties. Variations in production include the use of small amounts of light for the greening of leaves of some sprouts such as cress, and the obvious lack of need for weights for sprouts such as radish. Temperature is the most important variable in producing different types of sprouts. Keep in mind whether the vegetable is a cool- or warm-season crop when experimenting with different sprouting temperatures.

Sprouts of broccoli and other *Brassica* spp. have recently been found to contain large quantities of enzymes that protect against carcinogens. Levels of these enzymes are 10 to 100 times higher than those found in broccoli heads. For more information, see "Broccoli sprouts: An exceptionally rich source of inducers of enzymes that protect against chemical carcinogens" in *Proceedings of the National Academy of Sciences* (94:10367–10372). Other *Brassica* spp. sprouts containing large quantities of the enzymes include arugula, Brussels sprouts, cabbage, cauliflower, Chinese cabbage, collards, crambe, daikon, kale, kohlrabi, mustard, red radish, turnip, and watercress.

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SEED SOURCES

Seeds for sprouting are available from the following sources:

American Health & Nutrition
3990 Varsity Dr.
Ann Arbor, MI 48108
(800) 992-1818 ext. 18 or 19
e-mail: ahn@organictrading.com

Caudill Seed Co.
1201 Story Ave.
Louisville, KY 40206
(502) 583-4402

Dover Sales
1111 Greenwood Dr.
Peidmont, OK 73078
(405) 373-2850
(405) 373-2853 FAX

Hazel Ridge Farm
P.O. Box 268
Shellbrook, SK
CANADA S0J2E0
(800) 263-4490
(306) 747-3618 FAX

International Specialty Supply
820 E. 20th St.
Cookeville, TN 38501
(800) 277-7688
http://www.sproutnet.com

Johnny's Selected Seeds
Foss Hill Rd.
Albion, ME 04910
(207) 437-9294
(800) 437-4290
http://www.johnnyseeds.com/
e-mail: sprouts@johnny-seeds.com

The Sprout House
17267 Sundance Dr.
Ramona, CA 92065
(800) SPROUTS
(760) 788-7979 FAX

For information on equipment for commercial sprout production and seeds for sprouting, contact:

Caudill Seed Co.
1201 Story Ave.
Louisville, KY 40206
(502) 583-4402

Creative Craftsman
38 Fourteenth St. Buckhead Ridge
Okeechobee, FL 34974
(941) 467-6696
http://www.autosprout.com/

International Specialty Supply
820 E. 20th St.
Cookeville, TN 38501
(800) 277-7688
http://www.sproutnet.com

CONTAINERS

Any container that provides drainage and aeration and is rustproof and easy to sanitize is adequate for sprout production. Stainless steel or plastic is most commonly used. The size used depends on the scale of the sprout operation and the amount of seed to be sprouted. Mung beans increase in size about 6-fold when sprouting is completed. This can be used to determine the volume or weight of seed needed and the size of the sprouting container.

When using round sprouting containers, such as 2.5- to 5-gallon (10- to 20-liter) plastic pails equipped with drain holes, use about 3 to 4 pounds of seed in a 2.5 to 3-gallon pail (1.4 to 1.9 kg in a 10- to 15-l pail) or about 5 to 7 pounds of seed in a 3- to 5-gallon pail (3.0 to 3.3 kg in a 15- to 20-l pail). Some sprouting operations produce sprouts in the perforated-bottom plastic trays in which the sprouts are to be marketed. This is preferred or even required by some buyers.

SPROUTING

Use only untreated seed for sprouting, not pesticide-treated seed for that is used for planting. Pesticide-treated seed is usually dyed, but it may not be; check if you are not sure. Wash seed thoroughly, picking out foreign material and obviously blemished seeds. Soak seed in lukewarm water (90º to 95ºF, or 32º to 35ºC) for 2 to 4 hours, or soak at room temperature (68º to 72ºF, or 20º to 22ºC) overnight. This brings all the seed to uniform moisture content and begins the germination processes in the seed. After soaking, drain and rinse. Place in sprouting containers if different from the soaking containers.

For thicker yet still tender sprouts, which are preferred, apply a weight of about 0.5 ounce per square inch of surface area on the seed; a 2-pound (0.9 kg) weight would be needed for seed in an 18-inch (45-cm) diameter pail. Weights should be cushioned by placing a porous pad on the seed and then placing a perforated piece of rigid plastic (for ease of cleaning) or board on top of the pad. Set the weights on the plastic or board.

Temperature manipulations may also be used to modify sprout characteristics. It usually takes 4 to 5 days from the start of the sprouting process until the sprouts are ready for consumption; for best-quality sprouts, maintain a sprouting temperature of 70º to 80º F (21º to 26ºC) during the entire sprouting period. Temperatures from 80º to 85º F (26º to 30ºC) yield slightly quicker growth but produce more elongated sprouts. For maximum flushing of accumulated carbon dioxide and metabolic wastes and to provide adequate aeration and oxygen flow, sprinkle seed thoroughly with lukewarm water (70ºF, or 22ºC) every 4 to 6 hours, allowing the water to drain completely each time. The sprinkling frequency may be reduced to 6- to 8-hour intervals per day during the fourth and fifth days. Water temperature and frequency of watering must be monitored closely during the second day of sprouting to maintain the desired temperature, since this is when the greatest amount of heat is generated by the sprouting seeds. Sprouting seed must not be allowed to overheat or stand in water, since anaerobic conditions will develop, causing the seed to die or decay and greatly accelerating bacterial spoilage.

LIGHT

Light is not necessary in the germination process. Light causes greening, or the development of green color in the primary leaf. Greening is considered a defect in many types of sprouts.

QUALITY INDICES

Sprouts should be clean, brightly colored for the type, and free of damage, debris, and decay. Bean sprouts should be etiolated, lacking noticeable green chlorophyll, and have white root tips. Sprouts are typically harvested and washed to remove seed coats and nongerminated seed.

HARVESTING

Sprouts are ready to harvest after 4 to 5 days. Remove the weights (if used) and rinse away the seed coats as much as possible. Remove excess water just before packaging using a centrifuge or other means. This enhances the keeping quality if care is taken to avoid damaging the sprouts. The sprouts are then ready to use, process, or package for sale. Packaging is usually done in small, clear plastic clamshell containers.

POSTHARVEST HANDLING AND STORAGE

Rapid cooling is essential to achieve the full storage potential of sprouts. The high respiration rates and perishable nature of sprouts demand distribution and short-term storage at 32ºF (0ºC). Mung bean plants are classified as being chilling-sensitive; however, the sprouts are highly perishable and store best at 32ºF and 95 to 100 percent relative humidity. The respiration rate of mung bean sprouts is high, and the rate increases sharply with temperature; the shelf life decreases sharply with increases in holding temperature. Symptoms of deterioration are darkening of the radicle and cotyledons, dark streaks on the hypocotyl, and development of sliminess, decay, and a musty odor. Sprouts remain in good, salable condition at 32º F for 7 to 9 days. The shelf life of sprouts kept at 32ºF but exposed daily to 68ºF (20ºC) for 30 minutes can be reduced by 50 percent, which emphasizes the importance of immediate cooling and holding at 32ºF. At 36.5º, 41º, and 50ºF (2.5º, 5º, and 10ºC), the maximum salable life is 5.5, 4.5, and 2.5 days, respectively. Perforated film packaging has been reported to be helpful in maintaining the quality of sprouts of mung beans, soybeans, and adzuki beans.

DISEASE CONTROL

Bacterial decay (caused by *Pantoea agglomerans = Erwinia herbicola; Pseudomonas flourescens Biovar II; Pseudomonas maginalis;* or *Pseudomonas viridiflava*) is a common problem in many sprout types. It will develop very rapidly in production systems as well as in postharvest storage at warmer than optimal temperatures. High-quality seed and proper pregermination, seed treatment, and postharvest refrigeration are the primary controls. Washing sprouts in chlorinated or ozonated water (or other effective and approved disinfectants) helps control this decay and spoilage to a limited extent.

MICROBIAL CONTAMINATION ISSUES

Several types of seed sprouts have been clinically linked to notable outbreaks of bacterial pathogens, especially in recent years. Multistate incidents of highly virulent salmonella and enterohemorrhagic E. coli 0157:H7 have been traced to the consumption of alfalfa, mung bean, and possibly radish sprouts. Seed contamination has been positively identified as at least one confirmed source of contamination. Seed may be contaminated during seed production or during seed cleaning and packaging. Sprouts may be contaminated during germination or postharvest handling and packaging. During sprouting, contamination may occur through the use of nonpotable water or any direct or indirect source of fecal contamination from human

handlers, domestic or wild animals and birds, or improperly cleaned totes, bins, buckets, or harvesting implements or equipment. All handling surfaces in sprout production are food-contact surfaces and should be maintained as in any food processing environment.

In 1998, the California Department of Health Services led a petition for U.S. Environmental Protection Agency (EPA) Section 18 registration of a 2 percent calcium hypochlorite $Ca(OCl)_2$ treatment for alfalfa seed as the best available method to ensure elimination of pathogens from seed. The International Sprout Growers Association (ISGA) has endorsed this treatment as a voluntary industry-wide standard. The document *Microbiological Safety Evaluations and Recommendations on Sprouted Seeds* is available from the Center for Food Safety and Applied Nutrition (CFSAN) at http://vm.cfsan.fda.gov/~mow/sprouts2.html. An informational video is also available from CFSAN.

The use of a 2 percent $Ca(OCl)_2$ (20,000 ppm) soak before sprouting may reduce the risk of sprout-related illness. However, cracks and crevices in the seed coat may make bacteria inaccessible to lethal concentrations of disinfectants. High-dose soaks can reduce seed germination or be phytotoxic. Current research suggests that hybrid techniques using heat treatment combined with lower doses of calcium hypochlorite solutions may be effective and less damaging.

Mung bean and some other large-seeded or porous-coated sprout seed varieties may be more easily damaged by treatment with 2 percent $Ca(OCl)_2$. Grower caution is advised. Useful information on seed sensitivity and recommended disinfection treatment can be obtained from International Specialty Supply's informational website http://www.sproutnet.com/.

FOR MORE INFORMATION

Visit our online catalog at http://anrcatalog.ucdavis.edu. You can also place orders by mail, phone, or fax, or request a printed catalog of publications, slide sets, and videos from

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