Production of Naked-Seeded Pumpkin: A Food Crop for the Family Farm

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Naked-seeded pumpkin is a new crop of potential value for people who want to develop a lifestyle based on natural foods and self-sufficient food production. Most people like the taste of pumpkin seed, and the seed contains more protein than needed for human nutrition. Consequently, it can supplement foods made from grain crops that often lack sufficient protein for human needs.

Naked-seeded pumpkin has been tested, intermittently, at Rosemount, Minnesota since 1964 as a potential oilseed crop, but its yield and production costs do not justify commercial production for oil. However, some varieties do warrant production for edible seed.

Pumpkin acreage for planting stock seed in the United States totalled 302 acres in 1980, with an average yield of 529 pounds per acre. Most of this production was not of naked-seeded varieties. Acreage grown for confection or food seed is not known.

What Is Naked-Seeded Pumpkin?

Naked-seeded pumpkin (*Cucurbita pepo* L.) varieties were developed from natural mutants whose integuments (seed coats) were very thin in contrast to the thick, hard, and close-fitting integuments (hulls) of normal pumpkin seed. Pumpkin hulls are in close contact with the meat (cotyledons and primary axis) of the seed and cannot be removed efficiently by the methods used for dehulling sunflower.

Sunflower hulls are the pericarp (ovary wall) and are attached to the true seed at only one point (funiculus). Sunflower integuments, like those of pumpkin, closely contact the cotyledons and remain on the dehulled seed; therefore, dehulled sunflower seed and naked-seeded pumpkin seed are morphologically equivalent.

Varieties

The naked-seeded variety, Lady Godiva, was released by the USDA in 1972.[1] The fruits weigh about 5 pounds and are yellow with green stripes at maturity, but the green may continue to fade as senescence proceeds. The flesh can be sliced and eaten raw like a salad, but the flesh is of poor quality for cooking because of its stringy texture and pale color. The seed is green with very thin and loose integuments and is about three times the size of a dehulled sunflower seed. Test weight per bushel is about 43 pounds.

The Triple Treat variety was released by the W. Atlee Burpee Co. in 1977 and is used for jack-o-lanterns, cooking, and naked seed.[2] The deep orange flesh is of

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[1] Lady Godiva seed is available from W. Atlee Burpee Co., Clinton, IA 52732, and Geo. W. Park Seed Co., Inc., Greenwood, SC 29647.

[2] Triple Treat seed is available from W. Atlee Burpee Co., Clinton, IA 52732.

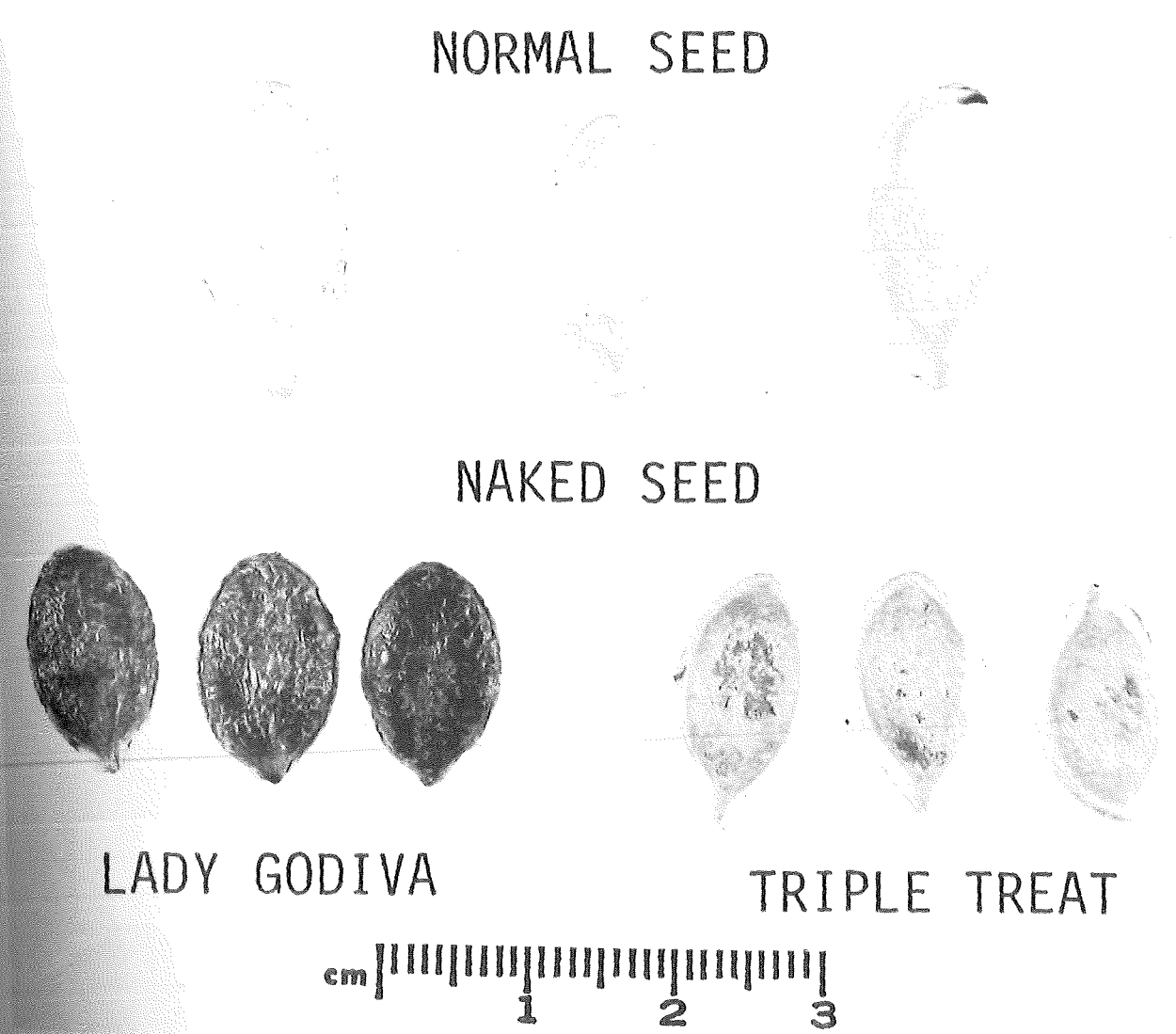

Figure 1. The normal seed is from a retail packet of the "crack and spit" type. Lady Godiva and Triple Treat are naked-seeded varieties.

good cooking quality. However, unlike Lady Godiva, the fibrous integuments are noticeable when the seed is eaten (Figure 1).

The Streaker variety is reported suitable for jack-o-lanterns, cooking, and naked seed.[3]

Nutritional Value and Chemical Composition

Pumpkin and sunflower seed have some similar nutritional characteristics, and both are potential food crops for the family farm. Data for seed of both crops are compared in Tables 1 to 3. Naked-seeded pumpkin seed exceeded sunflower meats in protein percentage and is a concentrated source of high quality protein (Tables 1, 2). Pumpkin and sunflower seed proteins are high in globulin molecules, and both crops are similar in amino acid composition. The essential amino acids for human nutrition are present in both crops, but more than the minimum amount of total protein must be consumed in order to provide the required amounts of methionine and cystine. Nonetheless, 0.33 to 0.44 pounds per day of pumpkin seed or 0.43 to 0.58 pounds per day of sunflower seed supply recommended amounts of protein and all essential amino acids for adults. These amounts contain 828 to 1,104 and 1,092 to 1,473 calories, respectively, for pumpkin and sunflower.

Protein percentages of pumpkin and sunflower are calculated by various methods. However, the methods are calibrated to give protein percentages based on the product of percent nitrogen times a nitrogen-to-protein conversion factor. The factor commonly used for both crops is 6.25, but the factor 5.3 has also been used. Analyses of naked-seeded pumpkin seeds grown at Rosemount and dehulled sunflower seeds grown at Rosemount, Morris, Crookston, and Grand Rapids, Minnesota indicate that nitrogen-to-protein conversion factors were 6.10 for sunflower and 5.65 for pumpkin.[4]

[3]Streaker seed is available from Burgess Seed & Plant Co., Bloomington, IL 61701, J. W. Jung Seed Co., Randolph, WI 53956; Nichols Garden Nursery, Albany, OR 97321.

[4]Robinson, R. G. 1975. Amino acid and elemental composition of sunflower and pumpkin seeds. Agron. J. 67:541-544.

Table 1. Average nutritional composition of Lady Godiva pumpkin seed and dehulled nonoilseed sunflower seed produced at Rosemount, Minnesota

Nutrient	Pumpkin	Sunflower
	percent[1]	
Protein	38.0	28.5
Oil	45.9	48.5
Ash	4.8	3.8
Fiber	7.9	4.0
Carbohydrate	11.3	19.2

[1]Dry-weight basis.

Table 2. Average amino acid concentrations in Lady Godiva pumpkin seed and dehulled nonoilseed sunflower seed produced at Rosemount, Minnesota

Amino acid	In seed		In seed protein	
	Pumpkin	Sunflower	Pumpkin	Sunflower
	percent			
Glutamic acid	5.19	4.76	18.30	21.74
Arginine	4.59	2.20	16.17	10.08
Aspartic acid	2.56	2.20	9.02	10.04
Leucine	2.16	1.53	7.58	7.00
Phenylalanine	1.54	1.16	5.43	5.29
Valine	1.49	1.21	5.25	5.51
Alanine	1.32	1.02	4.63	4.67
Glycine	1.29	1.18	4.54	5.39
Serine	1.19	0.87	4.19	3.99
Isoleucine	1.15	0.99	4.05	4.49
Lysine	1.14	0.85	4.01	3.93
Tyrosine	1.09	0.70	3.84	3.24
Proline	0.92	0.81	3.21	3.68
Histidine	0.76	0.62	2.68	2.81
Threonine	0.71	0.83	2.49	3.79
Methionine	0.65	0.50	2.27	2.30
Cystine	0.10	0.11	0.37	0.40
Tryptophan[1]	0.56	0.34	1.98	1.59

[1]Tryptophan data are adapted from Orr, M. L. and B. K. Watt. 1957. Amino acid content of foods. USDA Home Economics Research Report 4:1-82.

Both pumpkin and dehulled nonoilseed sunflower seed contained less than 50 percent oil (Table 1), but the sunflower oil is nearly 90 percent unsaturated compared with pumpkin oil of nearly 80 percent unsaturation. Minnesota sunflower oil is about 68 percent polyunsaturated (linoleic acid), whereas pumpkin oil is about 42 percent linoleic acid. Although sunflower oil is preferred, both oils have a satisfactory fatty acid composition for an edible oil.

The integuments contain much of the fiber in pumpkin and sunflower seeds. The integuments are not noticeable when sunflower seed is consumed, but they continually flake off of naked-seeded pumpkin seed. Because of this, consumption of fiber would be less than the 7.9 percent indicated in Table 1. Fiber is needed to regulate bowels, and seed fiber is desirable in a normal human diet.

Seeds of both crops are adequate sources of all minerals likely to be deficient in human diets except calcium (Table 3). An adult male must eat 4.4 pounds of pumpkin seed or 1.76 pounds of sunflower seed to get enough calcium. The phosphorus-calcium ratios also differ greatly from the desired 1 to 1. The high potassium-sodium ratio in these seeds is desirable nutritionally. Common diets contain too much sodium, so consumption of these seeds brings the potassium-sodium ratio closer to the desired 1 to 1.

Table 3. Average elemental composition of Lady Godiva pumpkin seed and dehulled nonoilseed sunflower seed produced at Rosemount, Minnesota

Element	Pumpkin	Sunflower
	percent	
Nitrogen	5.92	4.55
Phosphorus	1.37	0.91
Potassium	0.99	0.76
Magnesium	0.52	0.41
Sulfur	0.35	0..31
Calcium	0.04	0.10
Sodium	0.03	0.02
	parts/million	
Iron	94	63
Zinc	92	74
Manganese	44	26
Aluminum	14	2
Boron	13	6
Copper	12	25
Molybdenum	<2	6

Adaptation, and Time and Depth of Planting

Pumpkin is adapted to most well drained soils and has performed well on silt loam soil at Rosemount and on irrigated and dryland sand at Becker. Late maturity might be a problem in northern Minnesota. The seedlings are sensitive to frost and the seeds germinate very slowly in cold soil. Planting between May 20 and June 5 resulted in rapid emergence and allowed ample time for the seed to mature before killing frosts in September. The first frosts in the fall kill the top canopy of leaves, but the stems and protected lower leaves usually escape and maturation proceeds normally.

Naked-seeded pumpkin seed is usually of high germination and produces vigorous seedlings. However, the fragmentary seed coats do not protect the seed from rotting in the soil. The rotting problem is reduced by planting in warm soil and by use of fungicidal seed treatment. The seedlings can be grown to the cotyledon stage inside and then transplanted to the field. However, direct field planting at two or three times the desired population followed by thinning is generally more practical than transplanting. Satisfactory stands were occasionally obtained with untreated seed, but treatment was usually necessary (Table 4). Germina-

Table 4. Planting depth and emergence of treated and untreated naked-seeded pumpkin seed

Depth (inches)	Emergence (percent)		
	Untreated	Treated[1]	
	Field	Inside	Field
1	0	100	50
2	0	75	38
3	0	62	20
4	—	—	17
5	—	—	32

[1]Captan fungicide.

tion is rapid if the seed is planted in moist soil. The hypocotyl elongates and the cotyledons attached at the first node emerge about 7 days after planting. The hypocotyl is capable of elongating more than 6 inches, but deep planting delays emergence. A planting depth of 1 to 2 inches is optimum (Table 4). Flowers appear about 1 month after emergence and flowering continues for the rest of the summer.

Plant Population and Its Arrangement

Lady Godiva pumpkin produces long, prostrate runners about 10 feet long but many extend to 20 feet. Consequently, choice of row spacing does not limit final ground cover. A plant population of 10,454 plants per acre in a 30-inch x 20-inch arrangement gave highest yield, and 1,742 plants per acre in a 60-inch x 60-inch arrangement gave lowest yields at Rosemount (Table 5). The USDA in Beltsville, Maryland, reported higher yields from 10,890 plants per acre in a 24-inch x 24-inch arrangement than from 1,210 plants per acre in a 72-inch x 72-inch arrangement.

The rind and flesh remaining after seeds are removed are about 90 percent water, so the first treatment in Table 5 produced 1,185 pounds of seed and about 2 tons (dry weight) of fruit residue for hog or cattle feed. The residues remaining after seed removal are about 1 percent protein and 1½ percent fiber on a wet basis or about 12 percent protein and 15 percent fiber on a dry weight basis. The flesh of varieties of good cooking quality can be used for human food.

Weed Control

Good weed control is needed before the runners extend between the rows and prevent close cultivation (Figure 2). The tall, dense growth of leaves from the prostrate runners kills late emerging weeds. But early-emerging weeds in the row and those missed by the cultivator may be too tall for the pumpkin vines to control by shading.

Herbicides approved for pumpkin, but probably not tested on naked-seeded varieties, include chloramben (Amiben) at 3 to 4 pounds per acre preemergence or preplant incorporated and dinoseb amine (Premerge, Dinitro Weed Killer) at 3 to 6 pounds per acre preemergence. Dinoseb should not be used in sandy soil, and pumpkin seed should be planted at least 1 inch deep. Chloramben at 3 pounds per acre preemergence did not noticeably injure naked-seeded pumpkin and controlled annual grass and most dicot weeds in plots at Rosemount.

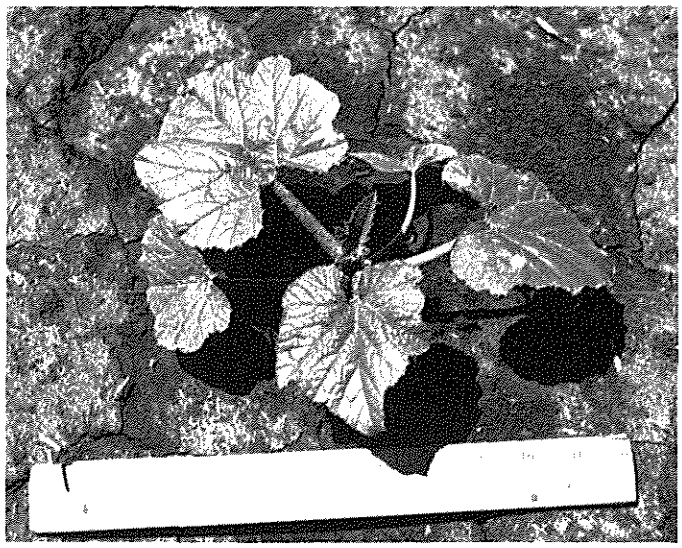

Figure 2. Plants at this stage can be cultivated.

Botanical Relationships and Seed Maintenance

Pumpkin belongs to the *Cucurbita* genus of the *Cucurbitaceae* family of plants. This genus includes four annual species. All are monoecious (male and female flowers are borne separately on the same plant) and require bees to transfer pollen. *Cucurbita* fruits are a type of berry called a pepo. The outer layer of the pepo is receptacle tissue covering the ovary. In turban types, the receptacle does not completely cover the ovary, and the pericarp is exposed.

The common groups of *Cucurbita* are not separated on the basis of botanical species as shown by the following classification.

Cucurbita pepo L. includes naked-seeded pumpkin; Connecticut Field, Jack-O-Lantern, Spirit, Spookie, Young's Beauty, Early Sugar, and Small Sugar pumpkin; Zucchini, Scallop, Patty Pan, Crookneck, Cocozelle, Straightneck, and Vegetable Marrow summer squash; Acorn, Table Queen, and spaghetti winter squash; and most ornamental gourds. *Cucurbita maxima* Duch. includes Big Max and Mammoth (Chili) pumpkin; Hubbard, Banana, Delicious, Boston Marrow, Buttercup, Kitchenette, Greengold, Turban, and Rainbow winter

Table 5. Plant population-plant arrangement effects on yield of Lady Godiva pumpkin at Rosemount; 1974, 1976, 1980 averages.

Plants/acre	Plant arrangement (inches)		Seed yield-dry		Fruit yield-wet		
			per acre (pounds)	per fruit (ounces)	per acre (pounds)	per acre (number)	per fruit (pounds)
10,454	30x20		1,185	1.6	52,000	11,572	4.6
5,227	60x20		825	1.7	37,000	7,542	5.0
5,227	60x60	(3/hill)	904	1.8	45,000	8,015	5.7
1,742[1]	60x60		774	1.7	42,000	7,277	6.0
LSD 5%			228	—	13,000	2,138	—

[1]1-year data adjusted to be comparable with 3-year data.

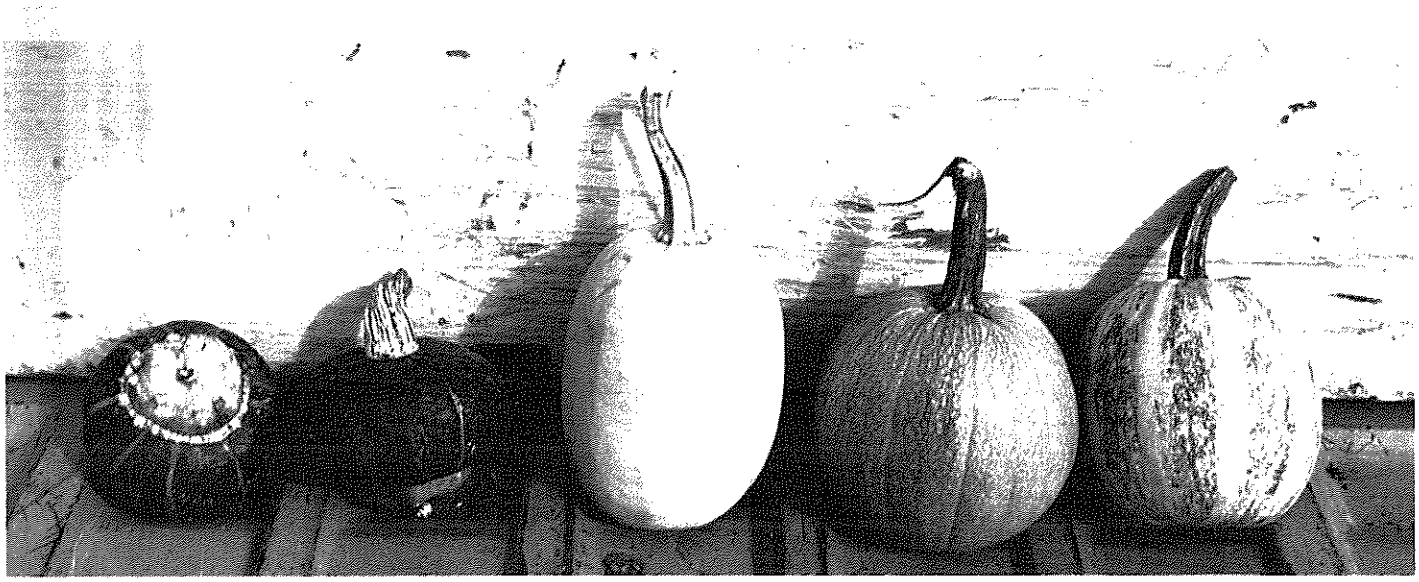

Figure 3. Fruits (pepos) of four varieties of *Cucurbita*. The two fruits at the left are buttercup winter squash *C. maxima*. The next three fruits are *C. pepo* varieties—spaghetti winter squash, Triple Treat naked-seeded pumpkin, and Lady Godiva naked-seeded pumpkin.

squash. *Cucurbita moschata* Duch. includes Kentucky Field, Dickinson, Cheese, and Cangold pumpkin; Butternut and Alagold winter squash. *Cucurbita mixta* Pang. includes Cushaw and Tennessee Sweet Potato pumpkin and Silverseed gourd.

Extreme variation within species of *Cucurbita* makes identification of species difficult. The stems and peduncles (fruit stem) of *C. pepo, moschata,* and *mixta* are generally hard and angular whereas the stems and peduncles of *C. maxima* are soft and round (Figure 3). However, the peduncles of *C. maxima* are enlarged by soft, corky tissue and those of *C. mixta* by hard, corky tissue. The peduncles of *C. moschata* flare out at their attachment with the fruit. Leaves of *C. maxima* are more rounded in outline and either not lobed or only faintly lobed compared to the other three species.

The naked-seeded pumpkin varieties will intercross with all annual *Cucurbita* species and varieties except *Cucurbita maxima.* Therefore, isolation is needed to prevent loss of the naked-seeded characteristic in subsequent generations. At Rosemount, ¼ mile isolation was not enough but 1 mile was sufficient to maintain pure seed. Naked-seeded pumpkin seed retains its viability for several years if kept dry in storage. Growers who wish to raise other varieties of *Cucurbita* could produce planting seed in an isolated plot or grow only varieties of *Cucurbita maxima* near Lady Godiva the year that planting seed is desired. No isolation is needed if the seed will be used for food. However, a few plants of naked-seeded pumpkin surrounded by other species of *Cucurbita* may produce some fruits without seed because of the parthenocarpic effect of foreign pollen.

Harvest and Preparation for Food

The seeds mature in September but the fruits are usually harvested in October after killing frosts. Lady Godiva fruits are yellow with green stripes; those of Triple Treat and Streaker are orange.

Some commercial seed producers may use vine crop harvesters to pick and thresh pumpkin in the field. The seeds and pulp are separated by washing and then dried. Seed may also be a by-product of commercial canning.

Seeds may be removed by cutting the fruit in half and scooping them out by hand or with a metal scraper. Or the fruit can be broken by slamming it against a pavement. Three double rows of seed are attached around the central cavity making hand stripping fairly efficient. The pulp and seeds are wet and slippery, but they can be separated by flushing with water through a container with a coarse mesh bottom. The seeds can be dried in thin layers on a screen, in a farm dryer, or in an oven. Low temperature drying is necessary if the seed is intended for planting.

The seed can be eaten raw, roasted dry, or roasted in oil. When dry roasted at about 350°F, the seeds make a popping noise and swell but don't invert like popcorn. A different flavor is achieved by lightly coating the seeds with oil before roasting. Roasting in an oven takes about 15 minutes. In a fry pan on top of the stove, the seed will burn in just a few minutes and must be covered to prevent the popping seeds from escaping.

Summary

Naked-seeded pumpkin is a "natural food" crop that produces about 1,000 pounds of edible, high-protein seed per acre. Pumpkin seed and sunflower seed have many nutritional similarities, but they are complementary in taste and texture. Both are staple foods that will supplement other foods that lack sufficient protein for good nutrition.

Naked-seeded pumpkin is also a potential oilseed and high-protein seed crop, but current varieties and production costs do not warrant commercial production.