Virginia Cooperative Extension

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Specialty Crop Profile:
Globe Artichoke

Anthony Bratsch, Extension Specialist, Vegetables and Small Fruit

Introduction

Globe artichoke (*Cynara scolymus* L.) is an herbaceous perennial that is grown for its tender, edible, immature flower buds. The globe artichoke should not be confused with Jerusalem artichoke, another member of the composite family native to North America, which is grown for its fleshy tubers. Globe artichoke plants can become large: four to five feet tall and wide, with long, heavily serrated silvery green leaves (Figure 1a). Unopened flower buds resemble large pinecones (Figure 1b). Buds can grow up to three to four inches in diameter, are rounded at the base, and tapering to the tip or blocky in shape. Many spiny, pointed, green bracts (small, leaf-like structures) surround the hidden flower parts. The buds are harvested at an immature stage before they open and expose the flower. The base of each bract and the large fleshy base or receptacle (artichoke "heart") on which the flower and bracts are borne are fleshy and edible. If the buds are allowed to mature and open, the resulting flowers are quite attractive, large, and fragrant (Figure 1c).

Fig. 1a. Typical globe artichoke plant nearing bud-development stage
(Photo by A. Bratsch)

Fig. 1b. Globe artichoke bud ready for harvest.
(Photo by A. Bratsch)

Fig. 1c. Globe artichoke buds expanded into full flower stage.
(Photo by A. Bratsch)

Globe artichokes are native to the Mediterranean region, but have been grown in this country since colonial times. Thomas Jefferson grew artichokes in his extensive food gardens at his central Virginia Monticello plantation as early as 1767, successfully overwintering the plants using protective coverings. Today, in this country, over 12,000 acres of artichokes are grown commercially in California's central coast area. The mild West Coast climate allows year-round perennial culture and quality

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bud production. In recent years, annual winter production systems using newer cultivars (cultivated varieties) have been developed in the southern desert areas of California and Arizona where growers target off-season market windows. California artichokes are shipped throughout the U.S. with little competition.

Market Potential

The development of cultivars suited to annual production has opened the potential for artichokes as a seasonal vegetable crop in Northeast and Mid-Atlantic states. Locally grown artichokes have been successfully marketed in upscale, Northern Virginia farmers markets. At roadside stands or farmers markets, individual buds generally sell from $0.75 to $2.00 each, depending on bud size and demand. Promoting "baby" artichokes, sold by the pound, may result in a market outlet for the many third- and fourth-tier small buds that represent over 50 percent of the annual production observed in Virginia trials (see Table 1). There is also market potential in high-end restaurants and local grocery stores for fresh whole buds or pretrimmed artichoke hearts. Processed (canned) artichoke hearts have potential as a value-added product.

Artichoke harvest occurs year-round in California. A peak and subsequent drop in commercial prices occurs from March to mid-May. For spring-planted annual production in Virginia, the expected harvest peak is from mid-August through September, a time when higher prices prevail. It may be possible to successfully overwinter artichokes in various parts of the state (see Notes on Overwintering) and obtain a late-spring/early-summer harvest, as well as a second harvest in the fall. However, spring planting with a late summer harvest window appears to be a more consistent and predictable system of production.

Market potential may also exist for cut artichoke flower sales by the stem or bunch. The flowers are large, of a brilliant blue hue, very sweet scented, and long lasting. Cut-flower production of various species has potential in Virginia for direct market sales. Artichokes could fit into this production scenario. For more information on getting started in field-grown cut flowers see *Field Production of Cut Flowers: Potential Crops*, Virginia Cooperative Extension publication 426-619, *http://pubs.ext.vt.edu/426-619/*, and *Getting Started in the Production of Field-grown Cut Flowers*, Virginia Cooperative Extension publication 426-618, *http://pubs.ext.vt.edu/426-618/*.

Adaptability to Climate and Soils

Artichokes have narrow preferences for climatic conditions. Considered a cool-season crop, they grow best at a 75ºF daytime temperature mean with 55ºF nighttime temperatures. They have an effective adaptive range of 45º to 85ºF. In Virginia, the best locations for annual production include the middle and upper Piedmont and mountain regions where elevation moderates high summer temperatures during late-summer bud development. Milder areas of the southeast coastal region may allow for fall planting and early-spring harvest, similar to the Desert Southwest system, though this "winter annual" system potential has not been evaluated. Annual production in Virginia's southern tier counties (Southside) is not recommended, as high summer temperatures create woody, bitter, less compact buds.

In order to form buds, new artichoke plants require "vernalization" or "chilling." This occurs just after planting, with seedling exposure to cool temperatures (eight to ten days or 190 to 240 hours of 50ºF or less) required for plants to initiate buds. Thus early spring planting is needed to meet this requirement. As a guideline, planting at, or a week or two ahead of the average last frost date for a particular region should provide time for adequate vernalization. Hot summer temperatures may reverse accumulated chilling hours, resulting in fewer plants producing buds. Newer cultivars seem more resistant to this "devernalization."

Artichokes are deep-rooted plants adapted to a wide range of soil types, but will perform best in well-drained, fertile, and deep soil. The extremes of heavy clay and light sandy soils should be avoided. Raised-bed culture is recommended where drainage is suspect, as it results in warmer soil temperatures in the spring and faster establishment.

Site Preparation

As noted, the planting period for annual culture is early spring with transplants set from late March through April. Because spring soil moisture is unpredictable, site preparation can be done in the fall under drier conditions. To enhance drainage, the site should be deep chisel plowed, followed by a broadcast application of phosphorus (P) and potassium (K) amendments. The field should then be disked and/or rototilled, and raised beds formed in heavier soils. Depending on a soil test, from 50 to 100 pounds of P per acre (as P_2O_5) and 100 to 200 pounds of K per acre (as K_2O) should be applied preplant. Nitrogen (N) should be applied at 50 to 75 pounds per acre. Nitrogen can be incorporated into the

raised beds just prior to planting or injected through the irrigation system.

Based on work by Virginia Tech near Blacksburg, best production was noted in beds covered with black plastic mulch with drip irrigation (plasticulture). Overall survival was better with plasticulture versus bare ground (Table 1) with a trend for higher total bud number and average bud weight. In warmer areas of the state, white plastic mulch may be a better choice, and growers are urged to experiment with this to help reduce midsummer heat build-up and plant stress. Plasticulture requires a specialized tractor attachment that forms beds and lays plastic and irrigation tubing in one operation (Figure 2). Beds should be formed in rows five to six feet apart, and raised four to six inches high. Drip irrigation tape with 10- to 12-inch emitter spacing should be laid under the plastic. In lieu of plastic, form a raised bed, and lay drip tape on the soil surface, using sod pins to keep it in place. Overhead irrigation can also be used, but it may result in excess foliar disease and weed problems. For information about sources for plasticulture equipment and drip irrigation supplies and designs, contact your local Virginia Cooperative Extension agent.

Fig. 2. Plastic mulch and drip irrigation application.
(Photo by A. Bratsch)

Cultivar Selection

Artichokes are known for their genetic variability, which results in non-uniform plant characteristics within a cultivar. It is not unusual to have 15 percent to 25 percent barren, non-producing plants in the first year, even under adequate posttransplant chilling conditions. Plants can also exhibit variable germination, habits of growth, and bud qualities. Several new cultivars used for annual production in California have been tested in Virginia. 'Imperial Star' (Keithly-Williams Seeds, Holtville, California), and 'Emerald' and 'Early Emerald Pro' (Palmer Seed Company, Yuma, Arizona) have produced well near Blacksburg. Table 1 describes their performance (see Handling, Sorting, Grading, and Storage for grade descriptions). From this data it is evident that the standard perennial cultivar 'Green Globe' is not well adapted for annual culture in this region, with only 15 percent of plants bearing in the planting year. Though it is popular in California for its large, high-quality buds, it requires overwintering and a perennial cropping system to realize its full potential. The other three cultivars were similar in their performance.

Propagation and Planting

Seeding

To ensure adequate time for vernalization, greenhouse-grown transplants should be used instead of direct field seeding. Seeds for transplants should be sown six to

Table 1. Survival and yield of four globe artichoke cultivars grown on black plastic mulch and non-covered ridged beds, Blacksburg, Virginia, 2002.[1]

Cultivar	Plant Survival %	Bearing Plants %	buds/ plant total no.	buds/ plant mkt no.	avg bud wt (g)	Bud Size Distribution by Packing Grade (buds/box)					
						18	24	36	48	Small >48 %	Cull %
						%					
E. Emerald	87	75	6.3	2.8	138.0	2.4	6.0	12.0	23.4	54.2	0.4
Emerald	88	83	5.9	3.1	148.5	3.0	8.8	13.3	25.4	46.2	1.6
G. Globe	84	15	1.2	0.5	165.4	1.1	1.6	7.4	18.7	65.4	0.0
Imp. Star	86	78	6.3	2.9	165.0	4.0	4.8	13.8	16.7	58.1	0.1
Soil cover											
Plastic	90	62.0	5.4	2.5	151.1	2.3	6.5	9.6	20.4	56.8	0.3
No-cover	81	63.8	4.5	2.1	141.4	2.8	3.6	13.5	21.5	55.3	0.3

[1]Plants spaced at two and one-half feet in six-foot wide rows for a population of 2,906 plants/acre.

seven weeks ahead of anticipated transplant date. Because artichokes develop a taproot, deep (three to four inches) cell trays are advised to prevent root circling (Figure 3). Seedlings will germinate in seven to ten days at greenhouse temperatures of 75º to 85ºF days and 60º to 65ºF nights. Beginning at the first true-leaf stage, a once weekly soluble fertilizer (100 to 200 ppm N) should be applied to keep seedlings vigorous. Plants should be hardened (acclimated) outside of the greenhouse in a cold frame or other protected area for seven to ten days prior to planting.

Planting

Use a measuring tape or other means to mark plant spacing. Two- to three-inch diameter holes should be made in the plastic mulch and soil. A sharp bulb planter, pointed trowel, or other hole punch device works well for this. Plants should be set two and one-half

Fig. 3. Globe artichoke seedlings grown in three different cell tray depths. Note the degree of root circling in the smaller cell, and the lack of root mass to hold soil together in the largest. The three-inch depth in the center appears to be ideal.
(Photo by A. Bratsch)

feet apart (2,906 plants per acre at six-foot between-row spacing) in the row. Use of closer spacings may result in less secondary bud production per plant, but also more plants per acre. A two-foot in-row spacing (3,630 plants per acre) has been used with some success. Use of a twin row configuration on the bed with 12 to 15 inches between rows, and with plants staggered three and one-half feet apart (4,148 plants per acre) between rows, may also be practical, and increase plants per acre. Population densities and resulting yield profiles have not been evaluated in trials in Virginia, so the grower is urged to test various configurations on a small scale. Irrigation rates will need to be adjusted to match planting density. Double-row configurations may require two drip tapes on each bed, depending on water movement patterns in the soil type. Installing a soil moisture-monitoring device, such as a tensiometer, is recommended.

Note: It is important not to set plants too deeply, as seedlings are sensitive to depth of planting (Figure 4). Root balls should be lightly covered with soil. A transplant solution (300 to 400 ppm N) should be used to water in each plant individually after planting. Within a few days, the irrigation system should be run until the beds wet from shoulder to shoulder.

It is not unusual to observe very slow early transplant growth; plants may sit for ten to 14 days with little noticeable growth. A small percentage of plants may die early; these and any weak plants should be replaced. This is likely a consequence of planting into cold soil. The soil in raised beds will warm sooner and speed growth.

Artichokes are tolerant of low temperatures (approximately 30° to 32°F); however, given the early planting date, protect young seedlings using a row cover or straw mulch if freezing or subfreezing weather is predicted.

Fig. 4. Plant set too deeply is experiencing delayed growth.
(Photo by A. Bratsch)

Field Management

Fertility

Artichokes develop significant aboveground foliage and require supplemental nitrogen fertilization during the growing season. Once plants are 10 to 12 inches in diameter (or approximately four weeks postplanting), soluble nitrogen should be applied. This can be done via the drip irrigation system, or by side-dressing granular material on bare-ground plantings. Depending on growth, approximately 15 to 20 pounds of N per acre should be injected every two to three weeks through early bud development. For side-dressing on bare soil, apply one-third of the total N application once every three to four weeks. Use a total posttransplant N rate of 80 to 125 pounds per acre. In general, nitrogen will

not be needed after the initial harvest. Plants should be monitored for sporadic buds from basal shoots formed late in the season. There may be a benefit from a low N application (10 to 15 pounds per acre) six to eight weeks after harvest to help promote development of these late buds.

Irrigation

Once established, artichokes require frequent irrigation during the growing season. This is particularly true as young plants begin to develop some size. Low soil moisture and plant stress during bud formation will result in loosely formed, tough, poor-quality buds that do not size well. Use a tensiometer or other means to monitor soil moisture and irrigate accordingly to keep soil moisture in the available range at 15 to 25 centibar tension, depending on soil type. Over-irrigation and long-term saturation should be avoided, especially on heavier soils. The amount of normal rainfall must be taken into consideration, especially in bare-ground plantings.

Growth Regulator Use

The application of the plant growth regulator (PGR) giberellic acid (GA) has been granted a federal label for use in artichoke and has been shown to enhance yield earliness and uniformity, as well as improve the percentage of marketable buds in perennial artichoke systems. Giberellic acid comes in several commercial formulations and is most commonly used in greenhouse production. Work at Virginia Tech has verified the benefits of using GA (as GA_3) in the annual system (see Table 2). It helped to induce bud development and reduce the percent of plant barrenness while increasing the overall bud number. GA requires several applications to be effective in artichokes. The first application should be made five to eight weeks after planting. Plants should be at least 12 to 15 inches across before making an application (Figure 5). This treatment is repeated two more times at two-week intervals. The material is applied by pressurized sprayer at 20 ppm concentration, using 50 gallons of water per acre. In work at Virginia Tech, GA applications starting at eight weeks were slightly more beneficial. This was likely related to the difference in plant size between the start of the two timings. A reduction in bud size was noted when using GA compared to no GA, and may be related to the increase in overall bud number or internal growth effects.

Fig. 5. Plants at approximately five weeks after transplanting; at stage for early GA application.
(Photo by A. Bratsch)

Table 2. Effects of GA_3 on yield of artichoke, Blacksburg, Virginia, 2004.[1]

		Bud Yield		
		buds/plant		
Treatment	plants w/ buds	total no.	mkt no.	ave bud wt
No spray	59	6.1	2.1	170
GA_3@5wks	87	10.9	3.5	144
GA_3@8wks	90	12.1	3.3	154

[1]Plants spaced at two and one-half feet in six-foot wide rows for a population of 2,906 plants per acre.

Pest Control

Guidelines for pest management in artichoke are not found in the *Virginia Commercial Vegetable Production Recommendations*. However, information regarding pest management can be found at the UC IPM Online, Statewide Integrated Pest Management Program, Agriculture and Natural Resources, University of California Davis, *http://www.ipm.ucdavis.edu/*. Herbicides, insecticides, and fungicides should always be used in compliance with label instructions. Growers should note that materials registered for use in California may or may not be registered for use in other states.

Weeds: Weeds can be managed through a combination of both pre-emergence and postemergence materials. Plasticulture production will require weed management between the beds, while bare-ground production requires weed management over the entire field. Several effective herbicides are registered for use in artichokes. Weeds can be mechanically managed by tillage as well. Once plants reach a certain size, the large leaves will shade the soil, discouraging weed growth.

Insects and other pests: Plants should be monitored regularly for insect damage. Aphids will be a primary

concern, congregating on the undersides of leaves and in bud bracts (Figure 6). Where present, cutworms and slugs can cause considerable damage to new seedlings. Earwigs also inhabit the crowns of plants, but do little damage, except leaving frass deposits. Plants should be scouted for two-spotted spider mites during hot weather. In Blacksburg, a small percentage of buds were infested by corn earworm. As this insect is prominent in the state, it should be monitored. Field mice and vole activity should be monitored under plastic mulch. These rodents will feed on fleshy roots and young shoots. Trapping or rodentcide baits can be used for control.

Diseases: Powdery mildew and Ramularia leaf spot can attack the bud bracts and foliage in artichoke, causing premature leaf drop and unmarketable buds. There are specialized chemical registrations in California; however, no nationally registered fungicide materials exist for artichoke. Be sure to select sites with good air movement and do not overcrowd plants. Young seedlings can damp-off (Pythium) following planting. This occurs in poorly drained soils. Verticillum wilt, a vascular disease, can also affect artichoke, as can an aggressive form of Pythium that was identified in Virginia studies, which infected mature plants. Symptoms for both diseases are sudden plant wilt in the field, especially as they gain size (Figure 7a, b). Both diseases are encouraged by saturated, heavy soils. (Note: Table 1 shows that 10 percent to 19 percent of plants were lost by season end at Blacksburg.) It is believed the annual cultivars and culture are more prone to this problem than established 'Green Globe' in perennial culture. Blacktip of buds was noted on some plants. This may be due to a physiological response related to reduced calcium uptake. The outside bracts of smaller buds were affected, turning them brown to black (Figure 8). It was primarily noted under conditions of moisture stress and high temperatures affecting plant water uptake and transpiration balance.

Fig. 6. Aphid infestation on lower side of globe artichoke leaf.
(Photo by A. Bratsch)

Fig. 7a. Damping-off of seedling by *Pythium* spp.
(Photo by A. Bratsch)

Fig. 7b. Loss of large plant by unknown fungal organism, likely *Pythium* or *Verticillium* spp.
(Photo by A. Bratsch)

Fig. 8. Bract darkening of globe artichoke bud caused by environmental stress and resultant calcium deficiency.
(Photo by A. Bratsch)

Notes on Overwintering

Because artichokes are a perennial crop, it is feasible in some areas of the state to overwinter them. In experiments at Blacksburg, plants were mowed to a height of six to eight inches in the late fall, and then covered with various protection materials. The best overwintering was achieved when rows were covered with a layer of hooped, vented clear plastic (Figure 9), which was then

Fig. 9. Vented plastic hoop to overwinter globe artichokes. When combined with a floating row cover, 30 percent to 40 percent of buds overwintered in Blacksburg, Virginia. This photo taken end of May. Note bud formation. (Photo by A. Bratsch)

covered with a floating-fabric row cover. Under this double covering, 30 percent to 40 percent of plants survived and produced high-quality, well-flavored buds in late spring. However, with no protection, a straw cover, a single-row cover, or clear plastic only, few plants survived. Some home gardeners have reported success using thick organic mulch which limits the depth of soil freezing. As at Jefferson's Monticello location, a greater percentage will likely survive under milder winter conditions.

Harvest

Depending on growing conditions, cultivar, and the use of GA, bud production will commence 60 to 100 days after transplanting. Expect the production period to be most concentrated over a six- to eight-week period. However, due to individual plant variability and new basal shoot production, a sporadic, light harvest will occur up to first frost. Thus plants should be continually checked for buds. Each plant has a primary flowering stalk from which will develop a main bud, along with secondary-, tertiary-, and even fourth-level buds (Figure 10). As noted, it is not uncommon to have more than one shoot originating from the plant base, usually flanking the main shoot (Figure 11). If the plants are vigorous, expect to harvest from these basal shoots. Not all basal shoots will be productive, but some will yield a complement of various bud sizes, usually later in the season. In general, primary and secondary buds are the largest and most marketable, while third- and fourth-level buds are too small. However, these are quite tender and can be eaten whole, and may be marketable with good promotion and consumer education.

Buds are harvested when they reach maximum size, but have not gotten tough and too far along in the floral development process. This is best indicated when the lower bud bracts begin to separate (Figures 12a, b, c). However, depending on cultivar, this expansion of bracts is not always clear and evident. There is also a subtle change in the color (less bright green) and appearance of buds as they reach harvest stage. The bud stem will also be somewhat loose and flexible, but stiffen as the buds mature. Buds should be cut using clippers, leaving two to three inches of stem attached. High air temperatures accelerate bud growth rate. Under warm conditions, expect to harvest up to two times a week. The expected percentage of bud yield, by size, and variety is presented in Table 1.

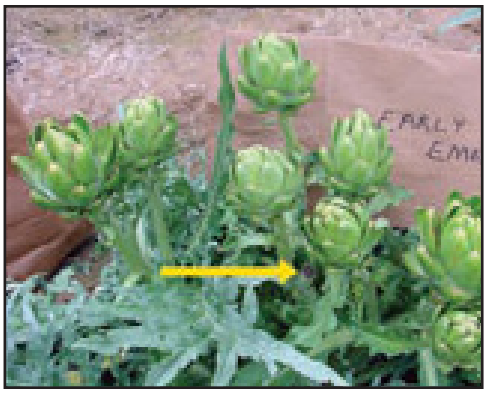

Fig. 10. Uniform and good yield for 'Early Emerald.' The center group is a collection of secondary and tertiary buds (note harvested stump of primary), and the side groups are primary and secondary buds arising from neighboring basal shoots.
(Photo by A. Bratsch)

Fig.11. Base of globe artichoke plant. Note two new basal shoots arising on either side of main plant. These will give rise to new bud sets.
(Photo by A. Bratsch)

Handling, Sorting, Grading, and Storage

Harvested buds should be inspected for insects, disease, and cosmetic damage. Buds maturing under excessive summer heat conditions (>85ºF) should be cooked and

Fig. 12a. Tight bud, not yet ready for harvesting
(Photo by A. Bratsch)

Fig. 12b. Buds ready for harvest. Note separation of bracts.
(Photo by A. Bratsch)

Fig. 12c. Over-mature bud.
(Photo by A. Bratsch)

tested for off-flavor or bitterness before marketing (see below directions). Non-marketable culls should be discarded, or if not bitter, trimmed for the hearts. In commercial markets, marketable buds are sorted according to size and quality. Standard grades include 18 (>four and one-half-inches), 24 (four- to four-and-one-half-inches), 36 (three-and-one-half- to four-inches), 48 (three- to three-and-one-half-inches) or 60 (two-and-three-quarter- to three-inches) buds per box. Smaller buds (one to two and three-quarter inches) are often "jumble packed" at an average of 100 to 175 buds per box. In general the fresh market prefers 24s and 36s. Since most artichokes are sold by the bud versus the pound, some retailers prefer 48s to maximize income.

Artichokes will store well for three to four weeks under proper cold storage conditions. Ideal storage temperature and humidity conditions are 32º to 34ºF and 90 percent to 95 percent humidity.

Utilization and Nutrition

Artichokes are easily prepared. Trim the stem even with the base of the bud and remove any dried or tough lower bracts. For large, spiny buds, the tips of bracts at the top of the bud are sometimes trimmed, but this is not necessary. Artichokes are cooked whole using a large saucepan, Dutch oven, or kettle. The buds should be placed upright in the pan with water added to a depth of two to three inches. Cover the pan and cook at a strong boil for 35 to 45 minutes, or until the bracts can be easily pulled off the bud. Drain the water. Artichokes are eaten by pulling the lower bracts off first and working toward the center of the bud. The fleshy base of each bract is eaten by biting and scraping with the teeth, usually after dipping it in butter or a prepared sauce. Once the outer bracts have been removed one at a time (this takes some patience) the center of the bud or the "choke," a fuzzy, spiny, and inedible center is exposed (Figure 13). It should be removed by using a spoon to scrape it out. Below it is the large floral receptacle or "artichoke heart," the most sought after edible part of the flower bud that the bracts were attached to.

Artichokes are nutritious, providing a significant source of folic acid, magnesium, iron, and potassium. Each artichoke has less than 40 calories, and provides about two grams of protein and nine grams of carbohydrates.

Fig. 13. Globe artichoke bud with leaf bracts stripped away to expose the "choke" in the center and the edible receptacle. Note damage by corn earworm, which burrowed through this bud.
(Photo by A. Bratsch)

Summary

The production of globe artichoke as an annual crop is feasible in Virginia. The best production areas are in the milder summer climates of the middle and upper Piedmont, and mountain elevations. The best production practices include the use of raised beds and plasticulture with drip irrigation and regular nitrogen fertilization. Choosing cultivars adapted to annual culture, and early planting to ensure vernalization, are essential for quantity and quality bud yield. The use of GA can help to advance harvest and improve the number, uniformity, and quality of buds. At the present time, direct marketing holds the best marketing potential for this crop. Wholesale opportunities may exist with local grocery stores or specialty grocers. A surprising number of East Coast consumers are not familiar with this crop, but for those who are, they represent a ready market for fresh, local artichoke buds. In the last several years, Virginia-grown artichokes have been shown to bring good prices in upscale Northern Virginia farmers markets. For consumers not familiar with this crop, education regarding preparation and use may be needed at point of sale.

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Cynara scolymus L. Compositae, or Asteraceae, *Alcachofa*, *archiciocco*, *artichaut*, Artichoke, *articiocco*, baby artichoke, *carciofo*, French artichoke, globe artichoke, Italian Green Globe, *karzochy*, Purdue university Center for New Crops & Plant Products, *http://www.hort.purdue.edu/newcrop/nexus/Cynara_scolymus_nex.html*

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