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Witloof Chicory (Belgian Endive) Trials — 1985

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Witloof chicory, known in the United States as Belgian Endive, is grown extensively in Western Europe, where it is consumed in great quantities. Consumers here are now discovering this versatile vegetable whose small, pale yellow edible head, called a chicon, has been forced to grow in darkness. It can be cooked as an entree or soup ingredient, or eaten raw in salad or as an hors d'oeuvre with a dip. Its rise in popularity is demonstrated by imports from Belgium increasing nearly seven-fold from 440 tons in 1976 to over 3000 tons in 1983, as reported by the U.S. Department of Agriculture. Today, witloof chicory is commonly found in markets with other salad greens rather than its former display among gourmet vegetables.

Most witloof chicory is imported from Belgium in winter. In 1983, however, imports began arriving in summer from New Zealand and Chile, and one grower now produces it in New York State.

In 1984 I began to investigate witloof chicory as a new crop for Connecticut because of its value, increasing popularity, and the similarity between the soils and climate of Connecticut and Northern Europe. In 1984 I demonstrated that witloof chicory could be grown in Connecticut on diverse soils and that during winter mature roots could be forced in cool, darkened enclosures to form chicons (Hill 1985).

In 1985 my investigations expanded to three sites and 26 varieties, called cultivars, from Holland to determine the ones best suited to Connecticut's soils and climate and the best of two methods of forcing. The 26 cultivars covered a wide range of maturity.

The witloof chicory grower must perform three tasks. First, he must grow healthy root stocks, 1-1/4 to 2 inches diameter in summer. Then, after harvest in the fall, he must age the roots from 4 to 16 weeks in cold storage. Then, he must replant the roots in a darkened enclosure at constant temperature and humidity to produce the edible chicon in about 3 weeks. Success is measured in terms of usable roots per acre for field production, minimal losses during storage, and the weight and quality of chicons after forcing. I report production of roots in summer 1985, storage of roots, and yields of chicons in winter 1985-86 under two management techniques. I also report on forcing for gardeners who wish to add witloof chicory to their array of home-grown vegetables.

MATERIALS AND METHODS

Seed and varieties. Graded seed of 26 cultivars was obtained from several domestic and foreign seed companies to provide an array of maturity to accomodate forcing from September through April under two management techniques. The 26 cultivars are classified by four periods for forcing: EXTRA EARLY: Arnova, Daliva, E-750; EARLY: Aksenta, Brussels, Michelse Mittlevroeg, Mitiva, Toner, Veneta, Zoom; MIDDLE: Fristo, Landova, Liber Mo, Spectra, Terosa, Topkrop B, Vianda, Videna, Wivro; LATE: Bea, Liber Lo, Nadin, Novibel, Nun 1700 (now called Faro), Viproda, Producent.

Field management. Trials were conducted at the Valley Laboratory, Windsor on Merrimac sandy loam, a sandy terrace soil with somewhat

limited moisture holding capacity; at Comstock-Ferre Farm, Wethersfield, on Hadley silt loam, a silty flood plain soil with a high moisture holding capacity; and at Lockwood Farm, Mt. Carmel, on Cheshire fine sandy loam, a loamy upland soil with moderate moisture holding capacity.

To prevent excessive top growth in the field and to discourage unfurling of outer leaves of the chicon during forcing no nitrogen fertilizer is usually applied. Root quality, on the other hand, requires adequate phosphorus, potassium and magnesium (Kruistum and Buishand 1982). Accordingly, all sites were fertilized with 150 lb/A P_2O_5 and 300 lbs/A K_2O, supplemented with 140 lb/A MgO supplied as Epsom salts (860 lbs/A). Lime was added to increase the pH of the soil to 6.5.

Since no nitrogen is applied, the crop must obtain nitrogen from decaying organic matter in the soil. A large proportion of inferior roots grew in the sandy soil at Windsor where nitrogen was leached by heavy rains during the summer. This suggests that in sandy soils if the crop appears stunted, a side dressing of 60 lb/A nitrogen may be needed in mid- to late July to counterbalance nitrogen losses.

Seeds of all 26 cultivars were planted by hand at each site between May 20 and June 10. Planting started at Windsor and concluded at Mt. Carmel. Rows planted 18 inches apart and thinned to 8 inches within the row produced a density of 43,340 plants/A. The herbicide Pronamide (KERB) was applied at 3 lb/A immediately after planting and watered in.

Because rain fell regularly throughout the 1985 growing season, irrigation was unnecessary.

Roots of each cultivar were tested for maturity in late August. A root was split lengthwise, and the fingernail-sized, white patch just below the crown was examined. At maturity this tissue is 1/4 to 3/8 inch thick (Fig. 1). Patches thinner than 1/4 inch are immature and will not produce tightly furled chicons (Anon. 1984). Patches thicker than 3/8 inch usually produce multiple heads or numerous crown shoots. The optimum root diameter is 1-1/2 to 1-3/4 inch. I saved roots that were between 1- and 2-inches diameter.

In 1985, I harvested the roots in two stages, pulling only the optimum sized roots at the three sites between August 29 and October 6. The remaining roots continued to grow and were harvested from November 15 to December 2.

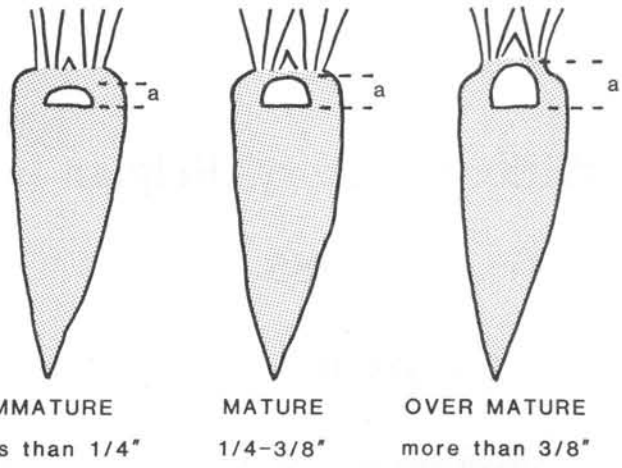

Fig. 1--Maturity of roots of witloof chicory as indicated by the thickness (a) of white patches from which chicons emerge. (Anon. 1984).

Whole plants were lifted and windrowed for 2 days. Wilted heads were severed 1 to 1-1/2 inches above the root crown, and roots trimmed to a length of 8 inches, with those that were too small or excessively forked, or from bolted plants, discarded.

At Mt. Carmel three rows of Zoom were left unmulched in the field during the winter. These roots were harvested March 28, 1986, trimmed and immediately forced.

Storage. The roots were placed in wire-mesh boxes to ensure ventilation, dipped in 10% bleach to reduce soft rot bacteria, and placed in cold storage. During cold storage, the root becomes vernalized and flower induction is initiated; until this occurs the root cannot be forced. In extra early and early maturing cultivars, vernalization may occur in 1 week (Huyskes 1961). In middle and late maturing cultivars, vernalization is slower and storage at 30-32 F is required to discourage decay (Kruistum and Buishand 1982).

Since our storage temperature was 40 F, I left the late forcing cultivars in the field until late November. Storage for 6 to 8 weeks at 40 F completed vernalization and permitted forcing of the roots.

For home forcing, harvested roots stored in

plastic bags were placed in a refrigerator for 2 to 12 weeks at 34-36 F.

Forcing. Roots were removed from storage and replanted in darkened enclosures in three environments: a heated greenhouse, an unheated barn basement and a partially heated home basement. The optimum temperature for forcing is 60 to 65 F (Kruistum and Buishand 1982). To attain this optimum range, the greenhouse was heated at night and vented during the day, causing the temperature to fluctuate between 60 and 70 F. The unheated basement of the barn had a daily fluctuation of less than 2 F, but in mid-winter cooled to 42 F. An electric heating cable was buried in the forcing mixture beneath the root tips to maintain a temperature of 65 F. The temperature in the home basement had little daily variation. The optimum temperature range of 60 to 65 F was maintained by simply moving the roots closer to the furnace in mid-winter.

The chambers in the greenhouse and barn basement measured 8 by 3 by 1.5 feet and were well drained. The sides were lined with 6-mil plastic. All chambers were covered with 6-mil black plastic to exclude light that would cause the chicons to become green and bitter. Plastic pails and garbage cans from 5 to 32 gallons were used for home forcing. These containers were punctured to provide a few holes for drainage and covered with heavy black plastic garbage bags to exclude light.

The forcing mixture was a 1:1 mix of mason's sand (fine sand) and peat. Sandy soil may also be used but may require sterilization to eliminate soil-borne diseases (Anon. 1985).

I used two methods of forcing: soil cover and no soil cover. Forcing with soil cover is the traditional European method. About 10 inches of unfertilized sand-peat mixture was placed in the forcing chamber to bury the roots up to their crowns. I planted the roots about 30 degrees from vertical, using a dibble to make the holes. Plant density was 25 to 30 roots per sq. ft., but less when forked roots were used. After planting the roots, the forcing mixture was watered thoroughly to the bottom of the bed. Another 4 inches of the mixture was added above the root crown but watered only lightly. This last step was eliminated in forcing without soil cover. All forcing at home in plastic containers was under soil cover.

The emerging chicons are usually ready to harvest in 3 to 4 weeks. If grown without a soil cover they are merely severed at the root crown and trimmed to remove unfurled leaves. If grown under soil the chicon and its attached root are uncovered, the root severed and the outer leaves trimmed to remove adhering sand and peat.

A single forcing includes planting of roots, growth and harvesting of chicons. Following harvesting of chicons, the roots are discarded and new roots are planted for the next forcing.

RESULTS

Yield of roots. The yield of roots is the first measure of productivity. A spacing of 18 by 8 inches produces a maximum density of 43,340 plants/A. The population of 41,440 plants/A at Windsor and 39,640 plants/A at Mt. Carmel indicated excellent germination and a spacing of slightly greater than 8 inches within the rows. The 21,510 plants/A at Wethersfield was only half the potential population. This low density followed poor germination after heavy rains and illustrates the sensitivity of chicory seeds to excessive moisture.

Not all plants produce satisfactory roots for forcing. Roots from bolted plants, those that had multiple forks, or were less than 1-inch diameter were discarded. Following the planting in late May through early June, losses from bolting were generally less than 2 percent for each cultivar in 1985. In mid-August, bolted plants were observed in the very early and early maturing cultivars indicating that these cultivars were beginning to reach maturity for harvest.

In contrast, following the planting in early to mid-May 1984 in my preliminary experiments, bolting of early cultivars was 10 to 20 percent. The increased bolting in 1984 was due to soil colder than 50 F at seeding, which promotes bolting (Anon. 1985).

During 1985 at Mt. Carmel and Wethersfield, 22 and 23 percent of the roots respectively were too small to force. At Windsor, 52 percent of the roots were discarded because they were stunted after nitrogen, potassium and magnesium were lost by leaching.

TABLE 1--YIELDS OF USEFUL ROOTS, STORAGE PERFORMANCE AND AVERAGE WEIGHT OF CHICONS FOR THE 1985 CROP. THOSE MARKED WITH AN ASTERISK (*) ARE YIELDS FOR MT. CARMEL AND WINDSOR, THE OTHERS ARE FOR MT. CARMEL ONLY.

	plants /acre	stor-age	g/chicon (forcings) with cover	g/chicon (forcings) no cover
EXTRA EARLY				
Arnova	29,690*	Good	70.6(4)	52.4(2)
Daliva	27,300	Fair	-	55.9(4)
E-750	31,420*	Fair	53.5(1)	48.7(6)
EARLY				
Aksenta	27.300	Fair	60.4(1)	-
Brussels	21.670*	-	-	-
Mich. Mittel.	40,090*	Poor	61.7(1)	-
Mitiva	28,640*	Fair	59.6(2)	59.7(2)
Toner	29,900	Fair	64.2(3)	55.7(1)
Veneta	36,190*	Poor	67.4(3)	74.1(2)
Zoom	33,590*	Good	67.0(8)	51.3(4)
MIDDLE				
Fristo	35,970	Poor	55.2(2)	-
Landova	35,970	-	-	-
Liber Mo	27,300	-	-	-
Spectra	32,290	Fair	-	54.8(1)
Terosa	31,640	Fair	55.7(3)	-
Topkrop B	30,340	Fair	67.3(2)	-
Vianda	34,020	Good	69.3(4)	-
Videna	32,940	Fair	69.3(2)	61.6(2)
Wivro	36,840	Poor	-	52.0(1)
LATE				
Bea	39,440	Good	74.0(4)	-
Liber Lo	40,740	-	-	-
Nadin	31,640	Fair	66.1(7)	-
Novibel	31,640	Poor	63.4(1)	-
Nun 1700	37,490	Poor	67.9(2)	56.4(2)
Viprova	37,490	Poor	86.6(1)	56.6(1)
Producent	37,490	Fair	60.6(4)	-
AVERAGE	33,040	-	65.3	56.6

The number of usable roots for each cultivar is reported in Table 1. The very early and early cultivars tend to produce fewer usable roots than middle and late cultivars. Evidently plant breeders have selected for earliness at the expense of plant size. I observed that the bolting plants of very early and early cultivars often had roots narrower than 1-inch. Michelse Mittelvroeg, Liber Lo and Bea had the most usable roots/A among all cultivars. In general, the average usable roots/A of most of the late maturing cultivars exceeded the average 33,000 for all cultivars, which is not surprising because they were left in the field longer before they matured.

Storage of roots. Successful storage of roots is the second measure of productivity. Roots may be stored briefly at 40 F, but long storage requires 30 to 32 F to prevent spoilage (Anon. 1985). Since our storage temperature was 40 F, we started forcing 2 to 10 weeks after harvest. Unfortunately, power failures during Hurricane Gloria in September caused loss of most of our early harvest. Although some extra early and early varieties were already being forced at the time of the power failure, middle and late cultivars became diseased and were discarded.

Storage losses of roots harvested in October through December were less than those harvested earlier. The roots of late November harvests had begun to vernalize in the cool soil and prolonged storage of several months was not necessary to complete the process. Virtually all roots of Landova, Liber Mo, Liber Lo, and Brussels were lost in storage due to the power failure. The storage performance of these cultivars is unrated.

The roots of several cultivars stored well. Losses of extra early Arnova, early Zoom, middle Vianda, and late Bea were less than 5 percent after 8 weeks storage at 40 F. I have subjectively rated the cultivars harvested after Hurricane Gloria in Table 1. Those rated good had less than 25 percent loss, those rated fair had 25 to 50 percent loss, while those rated poor had greater than 50 percent loss.

Commercial forcing. The production of chicons with uniform size and weight is the third measure of productivity. Chicons are sold commercially in standard 10 lb. (4540 g) boxes

containing the number of chicons to attain the standard weight. For example, a standard box might contain 75 chicons of 60 grams each. Since my production is experimental, I report the average weight of chicons for each cultivar (Table 1). The number of forcings from October through April is shown in parentheses. Since I found no significant differences in weight of chicons from roots grown at Windsor, Wethersfield and Mt. Carmel, the results have been combined in Table 1.

The averages at the bottom of Table 1 show chicons forced without cover weighed 14% less than those forced with cover. The reason for this decrease lies in the methods developed for our forcing sites. The barn basement had constant bed temperatures of 65 F. Ambient air temperature fluctuated little daily but slowly fell from 60 F in October to 42 F in February and rose again to 52 F by mid-April. The cold air required the roots to be forced with soil cover in the barn basement.

By comparison, the daily temperature in the greenhouse fluctuated between 60 to 70 F and the soil temperature rose to 70 to 72 F. These higher temperatures speeded the forcing of chicons with soil cover to 2 to 2.5 weeks and produced spindly heads with many unfurled leaves. Excessive trimming of these leaves was largely responsible for decreased chicon weight. After early attempts at forcing with soil cover in the greenhouse, I began to force without soil cover, and chicon weight and quality improved slightly. The results indicate, however, that darkened enclosures in greenhouses do not allow the required control of temperature and humidity.

Several cultivars have chicons with high average weights, (Table 1). Among the extra early cultivars, Arnova produced the heaviest chicons with tightly furled heads when grown with soil cover. In fact, a forcing in a home basement under a uniform temperature of 65 F yielded the heaviest chicons (91 grams/chicon). Daliva produced the heaviest chicons when grown without soil cover.

Among the early forcing varieties, Veneta, Zoom, and Toner were heaviest when grown with soil cover, ranging from 64 to 67 grams/chicon. All produced high quality chicons with tightly furled heads. Veneta produced the heaviest chicons when grown without soil cover.

Among the middle forcing varieties grown with soil cover, Vianda, Videna and Topkrop B produced chicons averaging 67-69 grams. The roots of Videna produced the highest weights among those cultivars grown without cover.

Two of the late forcing varieties were outstanding. Bea and Viproda, grown with soil cover, produced the greatest weight per chicon, exceeding 74 grams. Only two late forcing varieties were grown without soil cover. Nun 1700 (an experimental cultivar now called Faro) and Viproda required excessive trimming, which reduced the chicon weight.

Unmulched roots of Zoom, left in the field over winter and dug late in March for immediate forcing, produced chicons averaging 62.0 grams. The chicons were produced on roots with a diameter of only 1 inch and were smaller than those dug in the autumn. Larger roots failed to survive the winter.

Forcing at home. Witloof chicory can be grown by the home gardener with relative ease and forced without expensive equipment. It provides the avid gardener with a home-grown fresh vegetable as winter cloaks his garden with snow.

TABLE 2--AVERAGE WEIGHT OF CHICONS GROWN WITH SOIL COVER IN A PARTIALLY HEATED HOME BASEMENT AND IN AN UNHEATED BARN WITH A HEATING COIL IN THE BED.

	chicon barn/g	chicon home/g	home as % of barn
Arnova (Extra early)	61.1	88.4	145%
Bea (Late)	72.5	87.2	120%
Nadin (Late)	60.0	63.5	106%
Zoom (Early)	75.1	61.3	82%

Table 2 compares roots forced with soil cover in a home basement with temperatures between 60 to 65 F to roots forced in the barn basement forced with soil cover and a heating cable to provide constant 65 F bed temperatures. Arnova and Bea showed the greatest increase in average chicon weights in forcing in a home basement, 45 and 20 percent

respectively. Increase in average chicon weight of Nadin was modest. The average chicon weight of Zoom grown in a home basement was 18 percent less than when grown in the barn basement. For the most part, however, the home basement provided uniform temperatures near the optimum 65 F and produced the largest chicons.

CONCLUSIONS

My experiments show that witloof chicory can be successfully grown in the soils and climate of Connecticut. Production of roots for forcing is simple and relatively inexpensive. Storage and forcing of roots, however, requires control of temperature and humidity to produce quality chicons that can compete with European imports. I have shown (Hill 1985) that Connecticut grown chicons were judged equal to imports for keeping quality, and those who tasted them found them milder than imported chicons that had aged in transit from foreign lands.

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