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THE CHAYOTE: ITS CULTURE AND USES.

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NATIVE HOME OF THE CHAYOTE.

The chayote¹ (pronounced *chī-ō'tī*), a plant immigrant to this country from Mexico, Central America, and the West Indies, is of ancient cultivation in Central American regions. The perennial-rooted vine bears enormous crops of edible fruits (Pl. I) and in subtropical regions large edible tubers (Pl. II). These fruits and tubers were among the principal foods of the Aztecs, Mayas, and other peoples previous to the Spanish conquest of Mexico and Central America, and the vine is to-day one of the principal food plants of the inhabitants of these regions (Fig. 1), where it occupies fully as important a place horticulturally as does the potato in more northern latitudes.

ADAPTABILITY FOR CULTIVATION IN THE SOUTHERN UNITED STATES.

Recent experimental plantings in our own South and West under the direction of the Office of Foreign Seed and Plant Introduction of the Bureau of Plant Industry have demonstrated that the chayote is adapted for culture in the mild-wintered regions of the South Atlantic and Gulf Coast States and the southern coastal portions of California. Indeed, the vegetable has been grown for more than a generation (under the names vegetable pear, mirliton, mango squash, etc.) in certain restricted areas of the South, notably the

¹ Cook, O. F. The Chayote: A Tropical Vegetable. Bul. No. 28, Div. of Botany, U. S. Dept. of Agr. 1901. (A discussion of the botanical history of the chayote and of its commercial utilization in tropical America and other regions of the world where cultivated.)

region of New Orleans, La., Savannah, Ga., and Charleston and Columbia, S. C., where it is esteemed locally for its wholesome fruits. Doubtless only the natural conservatism of individuals with reference to their food habits has prevented the more rapid spread of the chayote in regions of the South and West where it can be grown successfully. Being of vigorous growth and prolific yield, a single vine in one's garden or yard or trained over a porch or outbuilding produces under favorable conditions of soil and climate

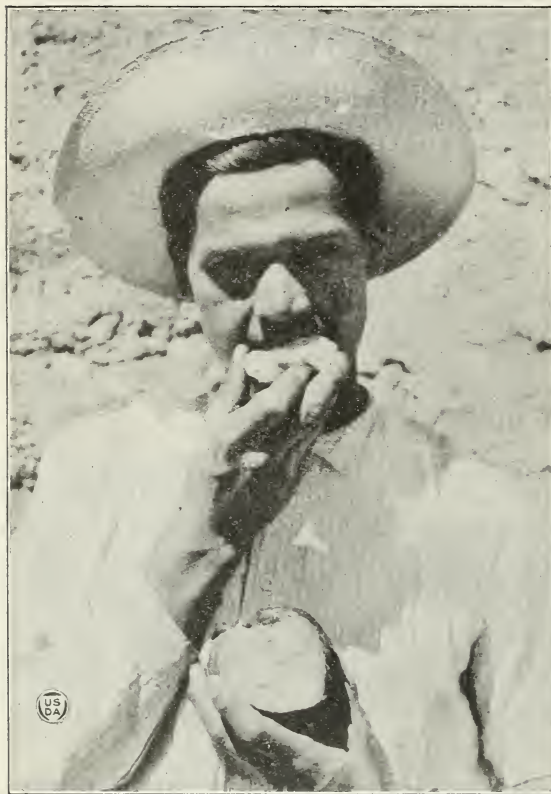


FIG. 1.—Chayote alamode in Guatemala. The chayotes are boiled and eaten out of hand without salt or other seasoning. (P17753FS.)

more than enough chayotes for the average family. In the South, where similar vegetable products mature at other seasons, the chayote provides an excellent fall and early winter table vegetable. The period of fruiting extends from early in October until the vines are cut down by frost. A secondary crop is often secured in the spring during April, May, and June if frost-free weather from about the 1st of February permits the vines to attain sufficient maturity for fruiting before the hot wet weather of the early summer.

It has recently been observed that some chayotes tend to set the fall crop of fruit considerably earlier than others. If this proves to be a habit

of some varieties or if a way can be found of forcing vines to set fruit by the middle of August wherever the plant will grow well, the chayote will be of value as an annual vegetable in many temperate regions. The habit of late fruiting in ordinary seasons in most regions limits the usefulness of the vegetable as a food plant to regions where no killing frost is ordinarily experienced until near the 1st of December. Chayotes reach full size in 25 to 30 days after the setting of the fruit. Investigations by Garner and Allard seem to indicate that the chayote belongs to that class of plants which are stimulated to flower and fruit when the daylight period is rather

short, the longer days of midsummer in temperate latitudes being favorable for vegetative growth rather than for flowering and fruiting.

VARIETIES OF CHAYOTES.

The chayote is a cucurbit, related to the cucumber and squash. The fruits, however, are unlike those of other cucurbits commonly grown. They are produced, usually singly, in the leaf axils of the growing vine, though on an unusually prolific vine two fruits occasionally develop at one node. Because of the variability of the chayote a number of types have arisen, whose fruits may be grouped according to color, size, surface, form, and quality of flesh.

The fruits in different varieties (Pl. III) range in color from dark green to ivory white; in size from those weighing a few ounces to fruits 2 pounds or more in weight; in surface from quite even (Pl. IV) to deeply wrinkled or corrugated (Pl. I) and from smooth to very prickly; in form from almost spherical, with no pronounced fissure, to long and flattened pear shape with a deep fissure at the blossom end of the fruits. In many varieties five grooves divide the fruit into five longitudinal segments. The depth of these grooves has much to do with determining the desirability of any given type of chayote. In quality chayotes vary from quite fiberless with no pronounced seed coat surrounding the single flat seed (see Fig. 4) to those having a tough, fibrous, inedible seed coat with fibers radiating into the flesh.

The results of recent experiments carried on at the United States Plant Introduction Garden, Brooksville, Fla., indicate that chayote fruits may vary considerably from seed in the first generation both in color, size, surface contour, and in the presence or absence of prickles. This variation is due, doubtless, to chance cross-pollination in the field. These results suggest that if certain varieties recognized to be good ones are to be kept true to type, it will be necessary to propagate them by means of cuttings, as described elsewhere in this circular, or to grow them in regions remote from other varieties in order to provide against cross-pollination. In discussing varieties of chayotes in Guatemala, Wilson Popenoe, Agricultural Explorer of the United States Department of Agriculture, remarks:

The question of varieties, I am convinced, is one of the most important ones in connection with chayote culture and one to which we have not as yet devoted sufficient attention in the United States. Unquestionably there are important differences in the quality of the different varieties cultivated in Guatemala, differences almost sufficiently marked to characterize the chayote as an excellent vegetable or to condemn it as a poor one, according as one samples a really good sort or one of the poorer ones.

The ideal chayote, from the market standpoint as well as from that of the home, is one of 8 ounces to a pound or more in weight, with smooth surface, fiber-free flesh, and a delicate agreeable flavor. Little has been attempted in breeding work with the chayote, but there is no reason to doubt the possibility of improving upon existing varieties.

CULTURAL DIRECTIONS.

The chayote can be grown as an annual much farther north than as a perennial, since the roots are rather easily killed by freezing. As many as 50 fruits were produced on a single vine as far north as Washington, D. C., in an unusual season when the first autumn frost was delayed until November 11. As a perennial, however, the chayote has not succeeded much farther north than Charleston, S. C. On the Pacific coast its cultivation seems to be confined to the southern coastal portions. In general, it may be said that the vegetable is adapted for culture in those regions where the ground does not freeze more than an inch or two.

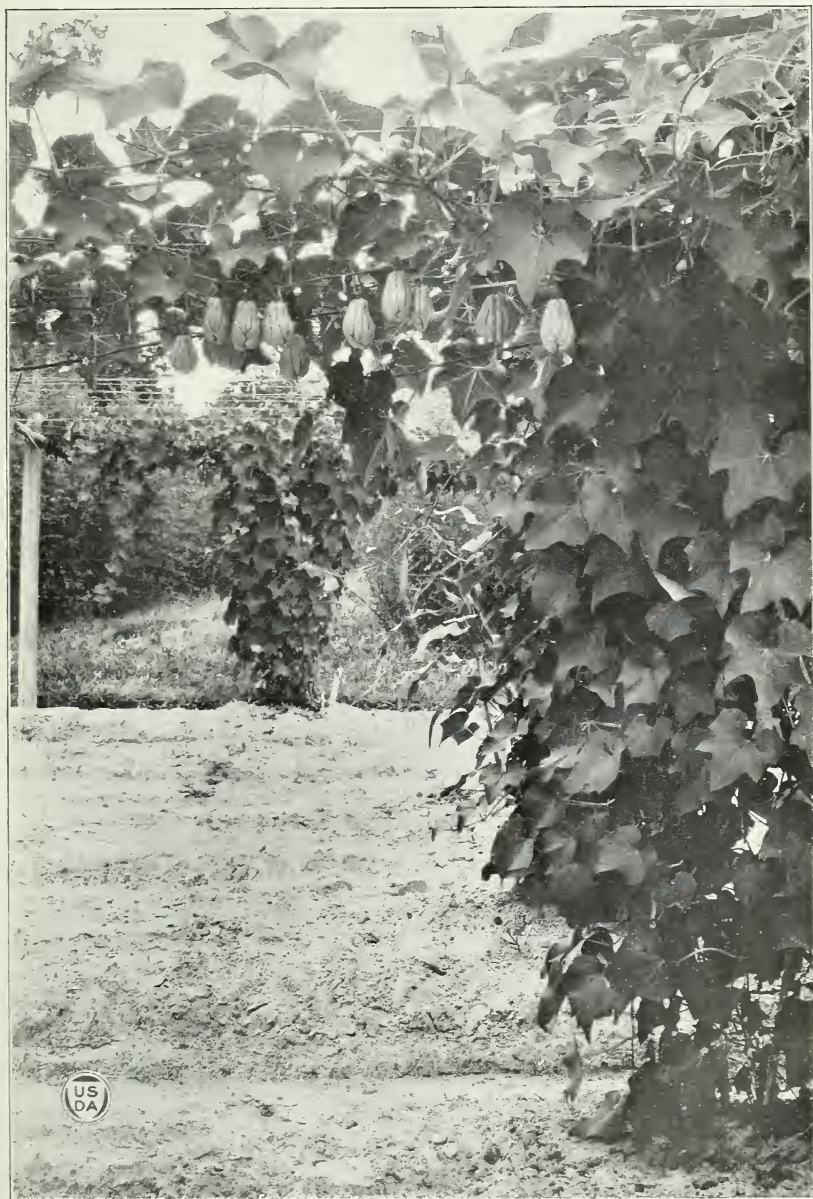
Soil.—Chayotes grow best in a rich well-drained sandy loam, but will do well in any good garden soil and in well-drained muck soils.

Planting.—Chayotes are usually planted in the spring as soon as danger from frost is past. In southern Florida it is possible to plant in the fall provided a thick loose mulch is applied in frosty and freezing weather to protect the tender young plants.

Preparatory to planting the chayotes, the ground should be dug or plowed deep and should be especially well worked where the fruits are to be planted. The entire fruits are planted, one in a hill, in rows about 12 feet apart. In order that the roots in large plantings may have as large an area as possible, it is advisable to plant in staggered rows. The chayote should not be planted deep. It is customary to place the fruit on its side with the broad end sloping slightly downward and the smaller or stem end left slightly exposed. If the seed to be planted has sprouted considerably, it is best to cut the sprout back to within an inch or two of the fruit.

Vegetative propagation.—Since chayotes do not always come true from seed, it is sometimes desirable to propagate a good variety by means of vegetative cuttings. Young shoots are removed with a sharp knife, close upon the crown of the plant and while they still show a solid tissue throughout. The cuttings are placed in coarse sharp sand until well rooted, after which they are potted in the ordinary way and grown in the greenhouse until it is desired to plant them in the field. If too much vine growth is made before the plants are set out, it should be cut or pinched back, in order that strong, sturdy plants may be secured. Care should be exercised in transferring the young plants to the field. The roots should be disturbed as little as possible, and the plants should be watered thoroughly if the ground is at all dry.

Cultivation.—Deep cultivation of the young chayote plants may be practiced at first, but as soon as they get well under way roots are formed near the surface which are seriously interfered with and even destroyed if deep cultivation is continued. Shallow cultivation, or in some soils mulching, may now be practiced. Experiments seem to indicate that after the plant becomes well established little cultivation is necessary. Weeds should be kept down about the plants and artificial watering practiced when necessary. A basin or depression should be formed about the plants to receive the water. To prevent a too rapid evaporation of the water and the baking of the soil, dry soil should be drawn about the plants after each watering,



A CHAYOTE VINE IN FULL BEARING.

The vine is a vigorous grower and very prolific. The variety here shown is ivory white and somewhat corrugated. (P23992FS.)



A GUATEMALAN INDIAN HOLDING A CHAYOTE TUBER.

These tubers are esteemed a very palatable food in Guatemala, where they are used much as the potato is used in this country. (P1757FS.)



VARIETIES OF CHAYOTES SHOWING DIFFERENCES IN COLOR, SIZE, SHAPE, AND PRICKLINESS—ALL FREE FROM OBJECTIONABLE CORRUGATIONS.

The fruit at the left and the prickly one next to the right end are light green, the most common color; the dark ones next to these are dark green; the light-colored fruits are nearly white. (P25856Fs.)



A RARE VARIETY OF SMALL, SMOOTH, WAXY WHITE CHAYOTE. (ONE-HALF DIAMETER.)

This variety was recently introduced from Guatemala and successfully fruited at the United States Plant Introduction Garden, Brooksville, Fla. Chayotes of this general type are called peruleros in Guatemala. (P25829FS.)

or a thick, loose mulch should be maintained about them, through which they may be watered without its removal.

Supports.—The chayote is a rampant grower and requires some sort of support. A fence, a tree (if not making too dense a shade), or an outbuilding may provide a fairly satisfactory support. If it is intended to grow chayotes commercially, however, large T trellises (Fig. 2), furnishing plenty of space for the vines, should be provided. A 4-inch-mesh heavy fencing wire run over the Ts makes an ideal support for the vines.

Manures and fertilizers.—Since chayotes are vigorous growers and gross feeders, they should be provided at all times with an abundance



FIG. 2.—A satisfactory type of T trellis for supporting chayotes in large plantings. Instead of single strands of wire, as shown here, wire fencing, 4-inch mesh, stretched over the Ts is more satisfactory as a support for the vines. (P24000FS.)

of the materials necessary for plant growth. Well-rotted stable manure, if available, gives very satisfactory results. In poor soils it may be necessary to supplement the stable manure by using a standard commercial fertilizer with a relatively high potash content. Vine growth may be stimulated by the use of sodium nitrate. Care should be exercised, however, to avoid an oversupply of nitrate, as it may kill the plants. About 5 ounces may be given a mature plant without injuring it, but care should be taken to prevent the nitrate from coming in direct contact with the foliage of the plants. Sodium nitrate may be applied either dry or in solution. If in solution the proportion of nitrate should be about an ounce to 5 gallons of water.

Since the chayote is a long-season plant, fertilizers should be supplied at intervals, as the plants seem to require nourishment.

Mulching for winter protection.—The chayote is a perennial, and if care is taken to protect the roots from freezing over winter by providing a thick but loosely packed mulch of hay, straw, weeds, or similar material during frosty or freezing weather, the vines will come up from the old roots in the spring. Under favorable conditions they will make a spring crop. The main crop, however, is produced in the fall, beginning toward the middle of October. If practically frost-free weather is experienced throughout the winter,



FIG. 3.—A crate showing a method of packing found to be very satisfactory in preparing chayotes for long-distance shipment. Although they may be packed without wrappers, the fruits carry better when wrapped. Two tiers of baskets with a layer of excelsior or Spanish moss over each tier are packed in an ordinary tomato crate. Regular orange and tangerine crates have also proved satisfactory, and as they have no baskets they hold more chayotes. (P19249FS.)

a condition which occurs in some years in parts of southern Florida and southern California, the vines may continue fruiting all winter and until the hot weather of the following summer.

Seed storage.—If intended for seed, chayotes should be permitted to remain on the vines until fully mature, but not until sprouts form. They should be handled carefully in picking, wrapped separately in thin porous paper, and packed in a box or crate with excelsior or similar material between the layers, so as to permit some air circu-

lation. The best results are obtained if seed chayotes are stored at a temperature that does not fall below 45° or rise above 60° F. The optimum storage temperature for chayotes is between 50° and 55° F.

Shipping.—Chayotes that are to be shipped should be handled with the same care as those for seed. It has been found possible to ship them satisfactorily in tomato crates, with or without wrappers (Fig. 3), but because of the added protection given by the wrappers and their tendency to prevent too rapid loss of moisture by the chayotes it is believed advisable generally to wrap the fruits, even with this type of crate. Ordinary orange crates or tangerine crates have proved quite satisfactory in cool or moderately warm weather and are economical because of the close packing of the chayotes that is possible. During weather of moderate temperature, if speedy delivery is not important and the time for the journey does not exceed 16 or 18 days, chayotes usually may be shipped with safety by freight. In hot or cold weather all long-distance shipments should go by express.

Diseases and insect and other pests.—Chayotes are sometimes attacked by fungous diseases, particularly following periods of excessive rainfall. No satisfactory control measure is known. Bordeaux mixture has been used with apparent success in checking fungous attacks, but it is not recommended as an absolute control measure. If the land drains poorly, an effort should be made to relieve the ground about the plant of an excess of moisture.

The pickle worm (*Diaphania nitidalis*) which attacks the fruits may be held in check by spraying with a nicotine preparation. The squash ladybird (*Epilachna borealis*), a leaf-eating insect, proves a serious pest in certain regions. Both the striped and spotted cucumber beetles (*Diabrotica vittata* and *D. duodecimpunctata*) also attack the foliage of the plants and may do considerable damage. These insects may be controlled by the use of a spray of arsenate of lead. Satisfactory results are obtained in combating fungous diseases and leaf-eating insects if arsenate of lead is added to Bordeaux mixture in the proper proportion. Pocket gophers, called locally salamanders, are reported to do considerable damage to the roots of chayotes in certain parts of the South. Ground moles often do much damage by tunneling among the roots in search of insects and worms. The winter mulch is often found to harbor insects and field mice, both of which are likely to injure the roots or young shoots. It is sometimes necessary to remove the mulch except in frosty or freezing weather, in order to prevent such injury.

In soils where the root-knot nematode (*Heterodera radicumicola*) abounds, the chayote roots become badly infested, and the plant is put under a serious handicap. It has been found that keeping an abundance of manure or fertilizer available for the plant enables it to withstand the nematode attacks very much better than it otherwise could. The chayote seems to withstand these attacks for one or two years as well as any other susceptible truck crop commonly grown in the South.

USES OF THE CHAYOTE.

Although the chayote is esteemed in this country chiefly for its fruits, in certain regions every part of the plant is utilized.

Forage.—The foliage of the vine is devoured eagerly by cattle and poultry, and in some regions where the vine flourishes without unusual attention it is used for forage. The plants show no injury from repeated cuttings of the new growth.

Ornamental vine.—As a porch climber or a covering for screens or arbors the chayote provides a very attractive ornamental vine.

Greens.—The young leaves and tender tips of the vines are utilized in the island of Reunion and elsewhere as greens, much as spinach is used in this country. Because a very tough fiber soon forms in the growing vine, only the tips of the vines that snap off easily are suitable for this purpose.

Blanched shoots.—Blanched shoots which are used like asparagus tips are obtained by forcing seed chayotes placed close together in a shallow trench and covered with loose earth or vegetable mold. The shoots are cut as soon as they reach the surface.

Bee plant.—The chayote flowers are provided with 10 nectaries each; consequently they are much visited by bees and other insects. Since the vines flower profusely throughout the fall months, the chayote is likely to be an excellent bee plant for regions where it can be grown successfully.

Chayote straw.—A very superior silver-white straw suitable for the making of ornamental basketry, hats, and other articles is obtained from the chayote vine. Previous to the World War a considerable quantity of this straw was exported annually from the island of Reunion to Paris, where it commanded a good price, but under present labor conditions the hand labor required for its preparation renders the price prohibitive. If some cheap method of manufacture could be discovered, chayote straw would doubtless become an important commercial product.

Chayote tubers.—The fleshy underground tubers (Pl. II) of chayotes are utilized in Guatemala, Mexico, and elsewhere as potatoes are used in temperate regions. These tubers are formed during the second season's growth, apparently as a reserve food supply for the plant after periods unfavorable to growth. Chayote tubers vary greatly in size, sometimes reaching a length of 2 feet or more and a diameter of 4 to 5 inches. The tubers are usually harvested after the second season's growth has been completed. It is customary to eat the tubers boiled as a part of a vegetable stew or fried in batter, with a thin tomato sauce added after cooking.

Chemical analysis of a Florida-grown tuber dug in January shows these tubers to possess a high food value. The fresh material was found to contain 16 per cent of carbohydrate (starch and sugars) and about $1\frac{1}{2}$ per cent of protein.

Since chayote tubers are generally considered inferior in quality to others and more common starchy tubers and can be harvested only at considerable risk of destroying the vines, it is advisable when the fruit is desired to permit the tubers to remain undisturbed.

The fruits.—As already indicated, it is as a fall and winter table vegetable that the chayote is chiefly valued. The chayote seed seems to have no dormant period. Consequently, when fruits become mature in warm moist regions, the seed begins to protrude by a growth of the cotyledons at the blossom end of the fruit, and sprouts often form even before the chayotes are picked. This sprouting continues

if the fruits are kept in a warm place after they are picked. Except that the flesh gradually shrivels, sprouting does not seem materially to affect the quality of the flesh. To prevent shriveling due to sprouting, the end of the protruding seed may be pinched off. Further shriveling may be largely prevented by wrapping the fruits singly in paper, packing them in excelsior, Spanish moss, or some similar material, and storing in a cool place (50° to 55° F.). The Guatemalan Indians pinch off the ends of the seeds of sprouted fruits which they wish to store for edible purposes and bury the chayotes in the ground, where they are said to keep in excellent condition for several weeks. Fruits intended for seed purposes can not be so handled; the seed should not be injured.

The following table shows the composition of chayote fruits without seeds (including analyses of mature Florida-grown fruits made by the Bureau of Chemistry of the United States Department of Agriculture) and of fresh seeds:

Composition of chayote fruit and seed.

Portion analyzed.	Water.	Protein.	Fat.	Total carbo- hydrates.	Fiber.	Ash.	Fuel value per pound.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Fruit, fresh.....	90.6	1.1	0.2	7.5	1.0	0.6	165
Seeds, fresh.....	32.8	5.5	.6	60.0	1.1	1,215

In percentage composition and energy value the chayote resembles squash and other succulent vegetables. So far as can be learned, no studies have been reported with reference to vitamins in chayotes.

The fruit of the best varieties of chayote has a mild but agreeable flavor and an excellent fiber-free texture. There is as little waste in the chayote as in the potato.

The seed is without a hard seed coat, and unless desired for use alone as a table delicacy it may be prepared and eaten with the rest of the vegetable. The seed has an agreeable nutlike flavor. After they attain a suitable size for cooking, chayotes may be eaten at any time, but the quality improves as they approach maturity.

RECIPES.

In preparing chayotes for the table they are usually cut crosswise (Fig. 4) into thick slices, pared, and boiled until tender in just enough salted water to cook them. For some dishes the fruits are cut in other ways, and if desired they may be boiled whole.

Creamed chayotes.—The chayote, previously boiled in salted water and diced, sliced, or segmented as desired, is excellent when served hot with a cream, butter, or tomato sauce.

Buttered chayotes.—Slice the chayotes about three-quarters of an inch thick, crosswise through the seed, and pare. Boil until tender in just enough salted water to cover, and drain; place in a serving dish, with butter on the top slices so it will melt over the lower ones, and serve hot. When prepared by this simple method the chayote is very attractive, of excellent texture, and of delicate flavor.

Fried chayotes.—Cut the chayotes, preferably crosswise, into slices nearly a half inch thick; pare, dip into bread or cracker crumbs or a beaten egg, and fry

slowly in a covered frying pan until tender. Sprinkle with salt and a little sugar if desired. Serve hot. Previously boiled chayotes are excellent when fried as described above.

Stuffed chayotes.—Cut chayotes in half lengthwise. Boil until tender and remove pulp, or scoop out the raw pulp and cook with the seeds in a small quantity of water until tender. Mash the pulp and season with butter, salt, and pepper to taste. Mince a small piece of cooked beef or other cold meat together with the boiled chayote seeds and a little onion and parsley and fry until brown; add to this the chayote pulp; replace the mixture in the skins, smooth over the tops with butter, and bake until well browned.

Chayote baked with cheese.—Place sliced chayotes in a saucepan with a piece of salt pork and cook until tender in just enough water to cook them. Season with paprika and salt. When tender remove slices with a skimmer and place in a baking dish. Prepare a white sauce, using the water in which



FIG. 4.—A chayote sliced crosswise preparatory to paring and cooking. This method of preparation is very satisfactory for general use. The thickness of the slices is varied from one-half to three-fourths of an inch, depending upon the kind of dish to be prepared. The single large seed is seen in cross section. (P25022FS.)

the chayotes were cooked and some milk, and pour over the chayotes. Cover with grated cheese and bread crumbs, add bits of butter, and bake to a golden brown.

Chayote fritters.—(1) Boil the sliced chayotes until tender and rub through a colander. For three cups of chayote pulp use 1 egg, 1 teaspoon salt, 1 teaspoon baking powder, 2 tablespoons sweet milk, sufficient flour to make a fritter batter. Stir pulp and batter together and fry like ordinary griddlecakes or drop by tablespoonfuls into deep hot fat and cook until brown. Serve hot, with or without sirup.

(2) Slice and pare the chayotes; boil until tender; dip in any preferred fritter batter and fry.

Chayote salads.—Because of its delicate texture and mild flavor the chayote is especially desirable for use in salads.

Prepare as for creamed chayotes, cool, and serve on lettuce leaves with mayonnaise or French dressing; or the boiled and diced chayotes may be served in a mixed salad with tomatoes, celery, or other vegetables.

Chayote pickles.—Young chayote fruits make excellent pickles, either sweet or sour pickles, or dill pickles. The chayote sweet pickle when well made is especially delicious. When used for such purposes the chayotes are usually cut lengthwise, though they may be cut in any manner desired. For making pickles, chowchow, or relishes, any favorite recipe can be used without any

other change than substituting chayotes for cucumbers, but the usual custom is to cook the chayotes for a few minutes before using them.

Other uses for the chayote.—Chayotes boiled, mashed, and seasoned with cloves or other spices and lemon juice somewhat resemble apple sauce and are palatable. They may also be used with any fruit juice for pie filling. Chayotes cut into pieces are often boiled with meats, or they may be boiled and served with other vegetables. If boiled and served alone, the addition of a little sugar in cooking is sometimes considered an improvement.

MARKET POSSIBILITIES.

The chayote is as yet but little known on the markets of the United States. As already stated, it has found a place in local markets in New Orleans and in some of the coast cities of California. A few merchants in southern and eastern cities have handled chayotes in small quantities as they came to their markets, but the vegetable will cease to be a novelty and rise to the position of a staple commodity only when its merits become more generally known.

Some of the larger hotels of the East have served chayotes when they could obtain them, but a very small acreage would supply all the fruits that could at present be absorbed through this agency. It will be seen, therefore, that the market possibilities of the chayote are contingent upon two conditions: The vegetable must appear in such quantities on markets over a wide field as to make it accessible to large numbers of people and through well-organized publicity campaigns the housewife must be induced to try the chayote on the table. Quantity production, of course, must precede quantity consumption, but at present quantity production of the chayote can be undertaken by the private grower only at considerable risk of loss. The initial expense of planting and equipping with suitable arbors even an acre of chayotes is considerable; moreover, the express rates to distant markets are heavy, rendering the margin of possible profit very narrow.

But while it would probably be inadvisable for growers to undertake the production of chayotes in quantity with the expectation of finding a ready market with large returns from their sale, the vegetable is of sufficient merit to warrant a place in every garden where it can be grown successfully in the South and Southwest. If the surplus from private gardens is placed on local markets and there kept constantly before the public, in a few years the chayote will become widely known as one of the dependable food crops of the region.

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