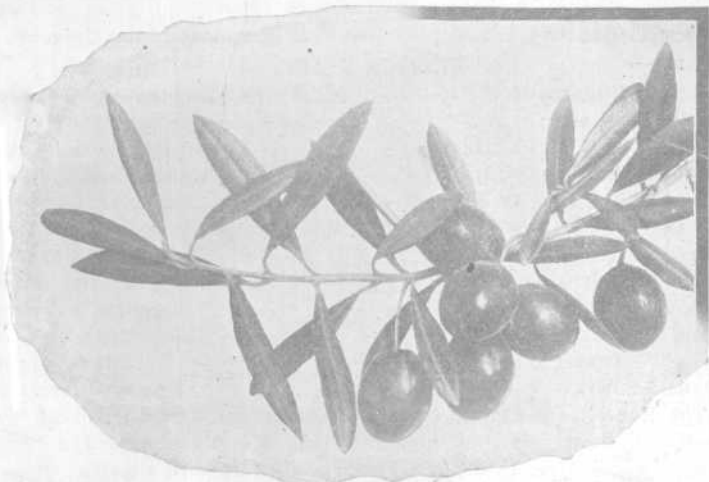


University of Arizona  
Agricultural Experiment Station.

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Bulletin No. 62.



Ripe Manzanillo olives, half size.

Olive Culture and Oil Manufacture  
IN THE  
Arid Southwest.

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By J. Eliot Coit.

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Tucson, Arizona, December 24, 1909.

# UNIVERSITY OF ARIZONA

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Visitors are cordially invited, and correspondence receives careful attention.

The Bulletins, Timely Hints, and Reports of this Station will be sent free to all who apply. Kindly notify us of errors or changes in address, and send in the names of your neighbors, especially recent arrivals, who may find our publications useful.

Address, THE EXPERIMENT STATION,  
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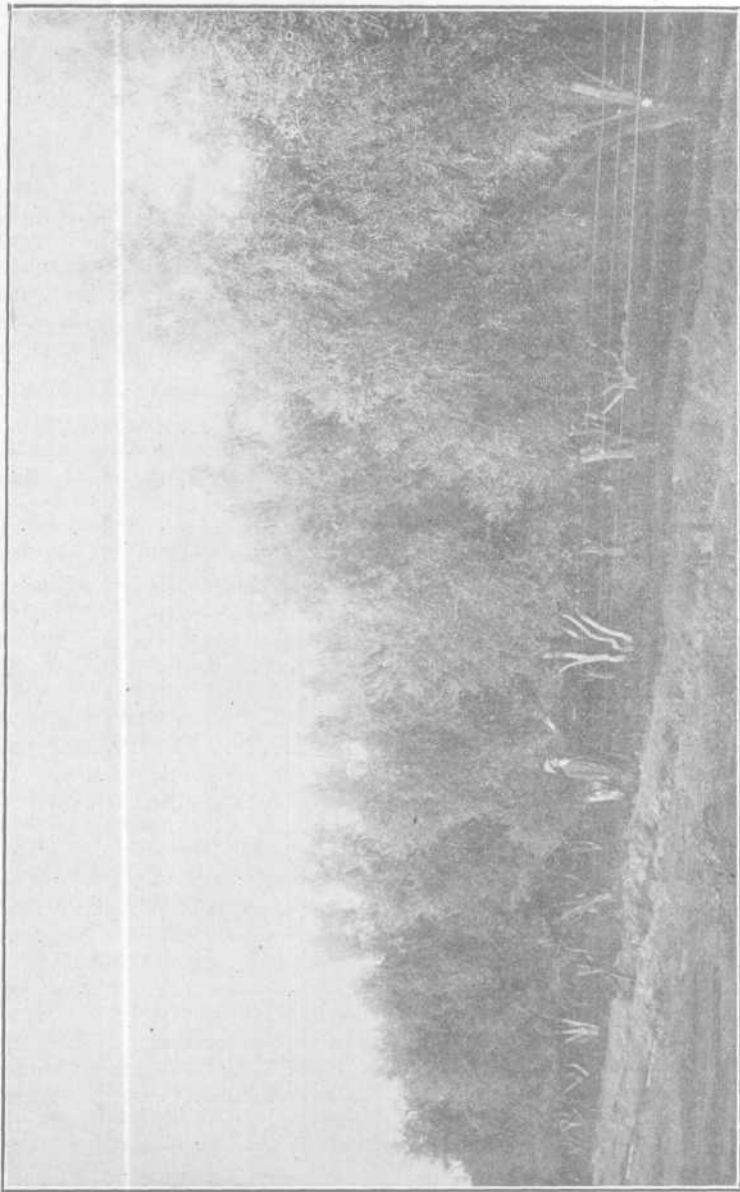


Fig. 1. Munger Bros.' olive orchard, near Phoenix, Arizona.

# OLIVE CULTURE AND OIL MANUFACTURE IN THE ARID SOUTHWEST.

By *J. Eliot Coit*.\*

## OLIVE CULTURE.

### CLIMATE.

From time immemorial the olive tree has been cultivated in countries bordering on the Mediterranean Sea. From this region, where it is native, it has spread to other countries in various parts of the World where the climatic conditions approximate those of its native habitat. For twenty-five years or more olive trees have been grown in Southern Arizona, and their state of health, vigor and productiveness today proves that the climatic and soil conditions of the inland arid Southwest are eminently suited to their culture. In general, for best development, the olive requires a hot, dry climate, where the temperature does not fall below 20 degrees F. A temperature of 24 degrees F. will usually injure the fruit, while 14 to 18 degrees will often do serious damage to the tree. These conditions are met in most of the valleys of Southern Arizona where the elevation is less than 3,000 feet. At the Station Farm, in Salt River Valley, the trees are never injured by cold and it is rare that the fruit is frosted.†

### SOIL AND IRRIGATION.

In its ability to withstand desert conditions the olive surpasses any other fruit tree, with the possible exception of the

\*Horticulturist of the Arizona Experiment Station until Aug. 1, 1909.

† Mr Milton Munger of Phoenix writes that on December 5, 1909, the thermometer registered 25 degrees in his olive orchard with the following results:

"The Manzanillo olives were frozen so that we had to stop pickling. The ripe ones were only shrivelled a little but the green Manzanillo olives rotted on the trees. Mission olives were only slightly frosted and pickled up well after the freeze. The Nevadillo were not affected by the freeze. About one half of the Columbella olives were frozen. All the other varieties were frozen, the ripe ones shrivelling badly and the green ones rotting."

date. Many instances are known of well started olive trees being abandoned for lack of water; and yet, although subject to desert conditions and the browsing of cattle for years, they still live and make a small growth each year. In Salt River Valley in particular many isolated trees and one small grove of the Mission variety have persisted for five or six years with no cultivation, and with no water except the natural rainfall. These trees still have a fairly good appearance, except that their tops are thin and very little growth is made. Practically no fruit is borne by our common varieties under these conditions. The fact, however, that they are alive and capable of being easily brought back into a state of profitable productiveness demonstrates the great value of the olive tree in an arid country, where the water supply is too often subject to interruption. In the case of citrus and deciduous fruits, the lack of water for a year usually means the loss of trees which it has taken years to grow. But the olive tree under such conditions simply drops its crop of fruit and awaits the return of irrigation water before setting another crop.

It is possible that in the years to come, when the economic status of this region will have more nearly reached an equilibrium and the cost of unskilled labor will have been lowered by greater competition, that considerable areas of our fertile desert land may be utilized by dry-land olive culture without irrigation. This will mean, of course, careful cultivation, skillful conservation of the "run-off," and the utilization of such drought-resistant varieties as the Chemlali, and perhaps others, introduced from Northern Africa. \*

However this may be, it is fairly certain that for quite a number of years to come, the chief concern of the olive growers of Arizona will be to raise the best varieties which we have at hand on valley lands, and under an established system of irrigation.

The olive prefers a well drained, light sandy or gravelly soil. It will thrive on almost any of the valley soils, except, perhaps, a very heavy adobe. A supply of water sufficient for a deciduous

\*See "Dry-Land Olive Culture in Northern Africa," by T. H. Kearney, Bull. 125, Bureau of Plant Industry, U. S. D. A.

orchard is hardly necessary for an olive grove, but the water used should be evenly distributed throughout the season, and each irrigation followed by thorough cultivation to retard evaporation from the soil. Occasional winter cover crops of sour clover or biennial cover crops of alfalfa will keep the soil spongy and in the proper physical condition to hold water.

#### PROPAGATION.

Like most of the deciduous fruits, the olive fails to come true from seed but reverts to a more or less wild and worthless type. From earliest times the olive has been associated with the more civilized peoples inhabiting the countries bordering on the Mediterranean, and consequently the selection and propagation of worthy seedlings has been carried farther than with almost any other fruit tree. It is no doubt due to this that a much larger percent of olive seedlings will prove worthless than with dates, oranges or peaches.

Desirable varieties are therefore propagated by layering, by grafting or budding upon seedling stocks, or by rooting cuttings. There are two principal methods of propagation by cuttings, viz; the soft-tip cutting and the large hardwood cutting. Nurserymen who have lath houses, and are thus provided with the means of controlling the conditions of light and moisture, prefer to use the soft-tip cuttings. They may be grown in a much smaller space and their root systems are much better. For these the tips of the growing shoots are cut about four inches long, being taken from the trees at the time when the wood is passing the herbaceous stage and growing hard and firm. They are cut just below a node and the two pairs of lower leaves removed. They are rooted in partial shade in boxes or beds of fine sand, which is kept constantly moist. After the roots are well started, they may be transplanted into beds of rich soil or into pots. If well grown, they may be planted in orchard form when one year old.

For the ordinary fruit grower who wishes to produce his own trees from some old tree of well known variety and bearing habits, the large cutting system is probably the best. Cuttings are made in January from branches one to two inches in diameter. The twigs are removed and the cuttings made about fifteen inches

long. They are tied into bundles and buried one foot deep in a horizontal position, in moist but well drained soil. In March they are taken up and set in nursery rows twelve inches apart in the row and twelve inches deep, usually at an angle of forty-five degrees. The loose dry soil is drawn over the tops of the cuttings forming a ridge, thus affording protection from the sun. If the middles are kept well irrigated for a few months, shoots will start from the sides and push up through the dry soil. All of these shoots are allowed to grow for the first year, after which the strongest one is selected and staked, the balance being cut away. By the end of the second year strong trees will be available for orchard planting.

#### PLANTING.

In the region under discussion, olive trees do best if planted between March 15 and April 30. They should be rather severely headed back when planted, and great care must be taken to avoid exposing the roots to the sun and the wind. The actual setting of the tree differs little from that of any other fruit tree. If all has been properly done, the new growth will begin to push out very soon after the trees are planted.

Perhaps the best distance for planting is twenty-five feet each way. Some varieties of olive trees if left alone will eventually crowd at this distance, but on account of the difficulty in gathering the fruit it is wise to keep them pruned low and in such shape that twenty-five feet will not be too close.

In certain localities some varieties, especially the Mission, seem to be self-sterile when planted in isolated blocks. It is therefore desirable to plant rows of different varieties together in the same orchard in order to insure cross-pollination, and consequently larger and more regular crops.

#### PRUNING.

Young olive trees should be headed back while in the nursery rows, the largest branches being cut back to two or three inches in length. In this condition they are planted out in orchard form, no further pruning being done during the first year. It is said to be very important to refrain from pruning or suckering during the first season's growth, as the proper development of the olive root system depends upon a large number of leaves.

The shaping of the tree should be begun during the dormant period at the end of the first season's growth. At this time all suckers are removed, wayward branches cut back, and the top headed at about three or four feet from the ground. Some growers prefer a tree with several trunks rising from the ground, but the single-trunk tree is more desirable.

In all subsequent pruning it should be borne in mind that the olive bears on wood of the previous year's growth. New twig formation should be encouraged throughout the body of the tree and along the larger limbs, but such growth should be kept thinned out and not allowed to become too dense and brush-like, as too much shade hinders fruit production. Many varieties, such as Razza and Correggiola, tend to produce very heavy crops of small olives in alternate years. This tendency should be corrected as far as possible by light annual pruning and thinning of the too thick twig growth. Olive trees should be kept sufficiently low for all the fruit to be gathered from a step-ladder. To do this will mean the occasional cutting back of the wayward upper branches, which if left alone will soon produce the bulk of the crop at an altitude too great for economical harvesting.

#### BUDDING.

As stated above, olive varieties are nearly always propagated from cuttings, and budding or grafting is therefore not necessary. It sometimes happens, however, that old trees of some undesirable variety are to be top-worked to some more profitable variety. This is best accomplished by budding. The trees to be top-worked should be headed back the previous year in order that a large number of vigorous shoots suitable for budding will have put out. The tree from which the buds are taken should also have been previously pruned to increase the vigor of the buds. A short twig an inch or two long and bearing several leaves is usually cut from a branch after the manner of a single bud scion. The larger leaves are removed and the twig inserted in the ordinary T-shaped incision and bound with a string. In three or four weeks the string should be removed and the bud examined. If it has "taken", the stock-shoot should be cut back in order to force the growth of the scion. As soon as the

scion has grown twelve or fourteen inches, the entire stock-shoot beyond the bud may be cut away.

Just after the sap has started in the spring is considered the best time to bud. It is wise to avoid giving an old tree too great a shock by top-working it all at one time. One-half of the branches may be budded one year and the other half the following year.

#### CULTIVATION.

Clean cultivation is very necessary with the olive where the careful conservation of water is essential. Continuous clean culture, however, will often defeat this very object, as the soil will gradually become so inert and devoid of humus as to be unable to retain water in proper quantities. It should be the aim to keep the soil in the best possible physical condition by growing and turning under occasional leguminous cover crops, such as sour clover (*Melilotus indica*), or alfalfa. The cover crop should be turned under and the land well irrigated just before the trees blossom, as an abundance of water is necessary for the proper setting of the fruit.

#### INSECTS AND DISEASES.

The olive trees of Arizona are exceptionally free from diseases and insect pests. As yet no olive scale has gained a foothold, and the trees are not only free from scale but the foliage is clean and thrifty, there being no sooty mould fungus (*Mehlota camelliae*), which lives on the honeydew secreted by the scale. During blossoming time the flowers swarm with several species of thrips, but as far as has been observed they in no way interfere with the proper setting of the fruit. The only trouble which is known to affect the olive in this region at the present time is a dry rot of the fruit which occasionally occurs in a mild form. This seems to be the same disease as that described, but not definitely named, on page 235 of the California Station Report for 1895-96: 1896-97. It differs from that, however, in occurring more commonly on Columbella than on Nevadillo olives. So far it has not been serious enough to cause complaint from growers

## YIELDS.

The age at which olive trees come into bearing varies with the variety. In general, however, if the trees have been well cared for, they will bear a few scattering fruits during their fourth and fifth years. When they are seven years old the crop should amount to several gallons per tree. After the age of ten years has been reached, the trees should yield an average of one hundred pounds per tree, or from three to four tons per acre. Large old trees may occasionally yield seven or eight hundred pounds at one picking. Such a large crop is almost sure to be followed by a light crop the succeeding year. Very heavy crops of olives are undesirable, because the fruits are small and thus the total percentage of pits to bulk of crop is much larger. Olive wood is brittle and the branches are prone to break to pieces under a very heavy load. For these reasons, olive growers should strive by systematic annual pruning to cause the trees to bear a medium load of very fine large olives every year. On account of the labor involved, it is doubtful if thinning the fruit by hand can be done with profit, except perhaps in the case of the very large fruited varieties used in making high grade pickles.

## THE OUTLOOK FOR OLIVE PRODUCTS.

The consumption of olive products in the United States is far in excess of the production, although there are facilities in this country for growing an amount of olives greatly exceeding the consumption. There are two chief reasons for this state of affairs. In the first place the wages paid for the labor necessary in the production of olives is approximately three times as much in the United States as in the olive growing countries of Europe and Northern Africa. This difference in the cost of production of raw material also applies to many other items in connection with the manufacture of olive products. It therefore follows that in spite of the duty on imported olives, the competition of European growers is keenly felt in this country. The following statement shows the total amount of olive products imported in 1907. More than one-half of the entire amount comes from Italy.

## IMPORTS OF OLIVE PRODUCTS IN 1905.

	Gallons	Value
Oils for food (dutiable).....	3,449,517	\$3,523,725
Oils for mechanical uses (free).....	1,471,766	682,656
Pickled olives (dutiable).....	2,298,480	1,277,973
Total.. . . . .	7,219,763	\$5,484,354

While it is not at all likely that wages in the southwestern United States will ever even approximate the European scale, it is probable that the discrepancy between the two will be gradually reduced, to a certain extent at least.

The second reason why olive production has not increased more rapidly in this country is the fact that until the last year or two pure American olive oil has had to compete in the market with cottonseed oil, labelled and sold as olive oil. The recent passage of national and state pure food laws has largely put a stop to this fraud. It will take many years, however, for the olive industry to recover from the injury done before these laws went into effect. The general public has become more accustomed to the substitution of cottonseed oil for olive oil, and many restaurant proprietors continue to fill their cruets with cottonseed oil. They doubtless have two reasons for doing this: the cottonseed oil is much cheaper and, naturally, a much smaller quantity is used by their patrons.

There is usually more net profit in making pickles than oil, hence it is good business policy to operate a pickling plant in connection with each oil mill. The olives are graded according to size, and the largest sizes are made into pickles. The American pickle market is capable of almost indefinite expansion, if the general Eastern public can be educated up to an appreciation of the great superiority of ripe over green pickles. Ripe pickles are consumed in large quantities and properly appreciated on the Pacific coast, while in the Eastern states they are rarely seen. A taste for green olives usually has to be acquired, while almost everyone enjoys ripe pickles from the first. Green pickles are used merely as a condiment or relish, and have very little food value. Ripe pickles on the other hand form an extremely nutritious and eupeptic food. Farm laborers

in Italy often make their mid-day meal of bread, wine and ripe olives, the latter taking the place of meat.

The great food value of the ripe olive is largely due to its high oil content, ripe Mission pickles often containing as high as twenty-five percent of oil. For detailed directions for pickling both ripe and green olives, the reader is referred to Timely Hint 53 of this Station.

The selling price of raw olives in Arizona has been quite low for the past few years, often running as low as eighteen or twenty dollars per ton on the trees. With this in mind, it may be well to add in conclusion that the growing of olives and their manufacture should be carried on cooperatively, to the end that both grower and manufacturer receive a proportion of the profits commensurate with the amount of capital invested in each branch of the industry.

## OLIVE OIL MANUFACTURE.

### EXPERIMENTS IN OIL MAKING.

The experiments described below were undertaken with five objects in view, as follows:

1. To determine the quality of oil made under the best conditions from Arizona-grown olives
2. To compare the quantity and quality of oil yielded by different varieties of olives.
3. To determine the comparative yield of oil from olives grown in rich moist valleys and on high dry mesas.
4. To determine the relative value and keeping qualities of oil from first, second and third pressings.
5. To determine the temperatures at which oils of the different varieties solidify.

In order to facilitate the work, a small laboratory was fitted up at the Station Farm near Phoenix and oil was made from the middle of December, 1908, till the first of February following. The fruit used was secured from three sources, viz, the Station orchards, where a number of varieties were growing on rather heavy, well irrigated land; Munger Bros.' ranch on the foothills, seven miles northeast of Phoenix, the soil being a light gravel; and the University campus at Tucson, where the soil is very thin, being underlaid by caliche.

Except where noted the olives were gathered and crushed on the same day. The fruit was picked in the morning and taken immediately to the laboratory, where it was run through a No. 5 Enterprise coffee mill. This crushed the olives fairly well but cracked only about one-half of the pits. After the desired amount of pulp was weighed it was at once put into the press.

This press was a small hydraulic press of the Buchner model, imported from Berlin especially for this purpose. Throughout

these experiments a maximum pressure of 640 pounds to the square inch was secured.

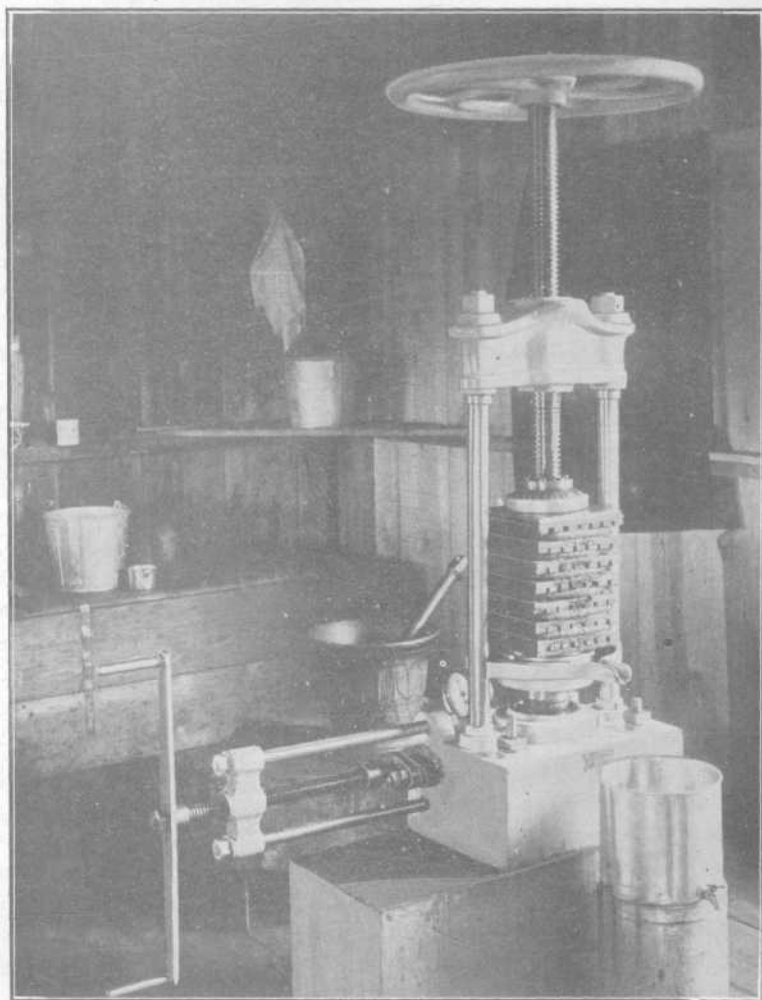


Fig. 2. Buchner press, with accessories, used in making press tests of olives.

The crushed olives were enclosed in small pieces of the coarse presscloth commonly used in oil mills, the corners being

folded over so as to form a cheese about three inches thick and eight inches square. Six of these cheeses were placed in the press, one above the other, alternating with heavy oak gratings one-half inch thick and eight inches square. In most cases about fifteen pounds of olives were used, and the 1000 to 1500 or more cubic centimeters of oil secured from each sample proved sufficient for our purposes.

The pressure was applied very gradually at first, as it was found that a too sudden pressure caused the pulp to squirt through the cloths. About three or four hundred pounds per square inch was usually applied during the first pressing. The liquid coming from the press consisted of a mixture of watery juice, oily pulp and clear oil. The juice was withdrawn from a cock at the bottom of the receiving can, and the clear oil skimmed from the top. The oily pulp was then set aside till the next pressing. The pomace was removed from the cloths and well pounded in a large iron mortar, thoroughly breaking up the pits. *This mass was moistened with the oily pulp from the previous pressing instead of with warm water, as is commonly the custom in commercial mills.* When this pomace was pressed again, at 640 pounds per square inch, the pulp did not squeeze out as before, but remained in the pomace. The liquid from this second pressing consisted of juice and clear oil, which could be easily and quickly separated.

The oily pulp which squeezes through the presscloth has long been a source of great vexation in small oil mills, on account of the great difficulty encountered in separating the oil from the very finely divided vegetable matter before fermentation takes place, thus injuring the quality of the oil. This is usually accomplished either by an expensive system of drying the olives before crushing, or by carrying the pulp through a series of tin receptacles with oft repeated skimming of the oil till the pulp is greatly reduced in bulk and is finally discarded or sold to the soap-maker. Another possible way of accomplishing the same result is by washing the oil with water in the device illustrated in California Station Bulletin 158, page 20. This contrivance, though much written about and often tried, has not been retained in general use in American oil mills. Theoretically it

seems ideal, but in practice it proves too complicated and cumbersome. In certain California mills, however, a considerably modified form is still in use.

In these experiments this great difficulty was obviated by substituting this pulp, while yet fresh, for all or a part of the warm water used to soften the mass of dry re-crushed pomace before it was pressed a second time. As above stated, the soft pulp does not come through the cloths with the oil a second time, but remains entangled in the more finely divided and dryer pomace. Since these experiments were begun, a large oil manufacturer has adopted this plan of working the pulp, and reports that it is entirely satisfactory and quite practical even with a press of large capacity.

Most of the samples of olives were pressed three times, though in a few cases four pressings were necessary. A pressure of from 300 to 400 pounds per square inch was used for the first pressing, and a maximum of 640 pounds per square inch was applied in the subsequent pressings. This amount of pressure compares favorably with that secured in California mills, which use the largest sizes of hydraulic press. These commercial presses usually give a maximum pressure of from 500 to 600 pounds per square inch. But even these powerful presses leave oil of considerable value in the pomace, which is fed to hogs or used in soap making. The pomace employed in Pressing No. 31 came from a commercial press which gave 490 pounds to the square inch. When 640 pounds to the square inch was applied to this pomace in our Buchner press, eleven gallons of oil per ton of pomace was secured. In order to decrease this loss, the writer suggests that in commercial mills, when the pomace is being pressed for the last time, it be made into smaller cheeses separated by gratings of perhaps one-half or two-thirds the area of those used for the first pressing. In this way the available pressure will be concentrated upon a smaller area, and much greater efficiency will be secured. The fact that the pomace is so greatly reduced in bulk by previous pressings as to be easily contained within the smaller cheeses lends greatly to the practicability of this plan.

In operating the press, the greatest care was used to preserve every particle of oil. The gratings were often flushed with warm water to prevent any re-absorption of oil from the cracks of the gratings when the pressure was released. The skimming was also done very carefully as it was realized that when working with a press of fifteen pounds capacity a slight loss of oil would, when calculated to the ton, be greatly magnified. It may be well to add, however, that the margin of error is on the conservative side; that is to say, the figures are bound to represent an understatement rather than an overstatement of the quantity of oil secured.

After the pressing of each sample of olives was finished, the oil from all of the different pressings was thoroughly mixed together and placed in a graduated glass column about three inches in diameter and allowed to stand from twelve to twenty-four hours, or until the line separating oil from water was stationary and well defined, after which the amount of oil was read to the cubic centimeter.

The oil was then placed in five-ounce bottles and kept in a cool dark place until May 1, when it was filtered through a corrugated glass funnel, using one thickness of soft filter paper, re-bottled, and sealed with wax.

Throughout the entire work close attention was paid to cleanliness. Everything with which the oil came in contact was scalded with strong lyewater every day, except the press cloths and gratings which were boiled in a cauldron of lye water about once a week.

#### *Ascolano.*

The Ascolano is an Italian variety. It is very large and watery and is chiefly used for green pickles. It is wine color when ripe and has a low oil content. The trees are prolific and bear well when irrigated. The fruit ripens from January 1 to February 1, after which date it drops rapidly. The olives do not ripen uniformly.

*Pressing No. 4, Dec. 22, 1908:* Fruit gathered at the Station Farm, about half ripe, was crushed and pressed at once, using twelve pounds, nine ounces. The juice was very watery and only 600 cc., or 25.20 gallons of oil to the ton was secured. The

fresh oil was free from acidity, and the flavor was rich and nutty. On May 1, after filtering, the oil showed a greenish-golden color, with a peculiar although pleasant flavor, free from acidity.

*Pressing No. 9, Dec. 29, 1908:* Fruit for this test was gathered at the Station Farm. Olives were selected which were ripe, deep red and beginning to shrivel. Fourteen pounds, twelve ounces were used in the test, and the pomace pressed three times. The result was 1070 cc., or 38.29 gallons of oil to the ton. After being filtered on May 1, the color was light greenish-yellow; flavor distinct, pleasant; aroma reminding one somewhat of pe ches; no acidity.

#### *Cajon.*

*Pressing No. 14, Jan. 4, 1909:* The fruit for this test was grown on the University Campus at Tucson. This variety should have been picked early in December, hence the fruit used represented the remnant of the crop. Nearly a week intervened between picking and pressing, and much of the fruit was shrivelled and showed decayed spots. Seven pounds, four ounces were used in the test, and resulted in 390 cc., or 28.40 gallons of oil to the ton. The fresh oil was free from acidity, but the flavor was poor, being somewhat musty. On May 1, after filtering, the color was greenish-golden and the flavor was much improved. While free from acidity and not objectionable, there was in the flavor a distinct suggestion of walnuts.

#### *Columbella.*

This variety is a vigorous grower and a prolific bearer under Arizona conditions. The fruit is an exception to the general rule in being much smaller when grown in Arizona than elsewhere. It requires about 157 to weigh a pound. The fruit ripens late and irregularly, turning red in December and jet black by May, by which time a large percentage will have fallen.

*Pressing No. 24, Jan. 11, 1909:* The fruit was grown at the Station Farm and gathered when partially ripe. Fourteen pounds, twelve ounces were used in the test, which resulted in 1101 cc. of oil, or 39.39 gallons to the ton. The pulp was very watery and squirted through the presscloth worse than any other variety. The fresh oil was very pale in color, flavor peculiar, with little or no acidity. On May 1, after filtering,

the color was pale greenish-golden. The flavor was peculiar and characteristic of the variety, but not disagreeable, with no acidity.

*Correggiola.*

This variety may be classed as strictly an oil olive. The fruit is small, averaging at the Station Farm about 155 to the pound. It usually colors at one end first, and matures irregularly from January to May. This variety will hang on the tree without shrivelling till June 1, or even later, and is valuable in extending the pressing season. The tree is very prolific and tends to overbear on alternate years. The fresh fruit is exceedingly bitter.

*Pressing No. 5, Dec. 22, 1908:* The fruit for this test was gathered at the Station Farm, fairly ripe but with many green ends, twelve pounds, eleven ounces being used in the pressing. The crushed olives formed a paste instead of a watery mass like other varieties. The result was 1060 cc., or 44.12 gallons of oil to the ton of olives. The color of the fresh oil was bright green, and there was a decided acidity. On May 1, after filtering, the color was a very beautiful bright greenish-yellow; the flavor was very good, the previous acidity having disappeared; the quality was of the very best.

*Pressing No. 30, Jan. 18, 1909:* On this date a second pressing of olives from the same source was made, selecting only fully ripe fruit. In the pressing fourteen pounds, twelve ounces were used, the result being 1436 cc., or 51.39 gallons to the ton. The fresh oil was acrid, as before, but by May 1 this had entirely disappeared and the filtered oil showed a beautiful golden color, while the quality and flavor were of the very best.

*Grossana.*

This is an oil olive of medium size, ripening unevenly in November and December

*Pressing No. 8, Dec. 28, 1908:* Fruit of this variety was secured from Munger's ranch near Phoenix. It had been picked five days when pressed. The fruit was perfectly ripe and a few berries were beginning to shrivel. Fourteen pounds, twelve ounces were used in the test, the result being 1175 cc., or 42.01 gallons to the ton. The fresh oil was greenish-golden in color,

with an acrid taste. On May 1, after filtering, the clear oil was greenish-golden in color, of fair quality. The flavor was fair, though somewhat peculiar, and with a slight acidity.

*Manzanillo.*

The home of the Manzanillo olive is in Spain and southern France. It ripens very early in Arizona, usually during October, and drops from the trees before Christmas. The fruit is large and almost round, though sometimes somewhat elongated. It colors evenly, and all the fruit on the tree tends to ripen at the same time, which is a very valuable character as it greatly facilitates harvesting. The tree is a vigorous grower and a heavy bearer.

*Pressing No. 1, Dec. 17, 1908:* The olives were gathered at the Station Farm and were dead ripe, being the last remnant on the trees. Twelve pounds and twelve ounces were crushed and pressed immediately, the pomace being pressed three times. The juice was very dark red, and the oil rose to the surface very quickly. After standing in the graduate four hours the line between oil and juice had become distinct. The amount of oil secured was 840 cc, or 34.74 gallons to the ton of olives.

*Pressing No. 2, Dec. 18, 1908:* A duplicate pressing was made on the following day, using eleven pounds, twelve ounces of olives. The yield was 780 cc, or 35.08 gallons of oil to the ton. On May 1, after filtering, this oil was found to be of very good quality with no acidity; flavor fair but somewhat greasy; color pale yellow. This oil solidified at high temperatures, and consequently had to be warmed before filtering.

*Mission.*

The Mission olive as grown in Arizona is the same as the common or broad-leaved Mission which originated from seed at the old missions of California. The tree is a vigorous, upright grower and is very prolific. The fruit is large and jet black when ripe. It ripens very unevenly from the first of December until March. The fact that one branch may contain olives in all stages of ripeness from perfectly green to jet black and shrivelled is the only serious objection to the variety. Otherwise it is one of the very best for Arizona planters, being well adapted both for pickles and oil. The flavor of Mission oil ranks

with the best, but the color is not as high as that of Correggiola, Pendulina, and some others.

*Pressing No. 11, Dec. 29, 1908:* The fruit for this pressing came from the Station Farm. It was fully ripe, some berries being slightly shrivelled. It was crushed and pressed immediately after picking, fourteen pounds, twelve ounces being used. The result was 1468 cc, or 50.08 gallons to the ton. The fresh oil was of very good flavor and free from acidity. On May 1, after filtering, this oil was of the best quality, with a very fine rich nutty flavor free from acidity. The color was pale golden.

*Pressing No. 18, Jan. 6, 1909:* The fruit used in this test was grown on the University campus at Tucson, and about five days intervened between picking and pressing. The fruit was dead ripe and beginning to wrinkle. Fifteen pounds were used in this test, which resulted in 15cc, or 30 53 84 gallons of oil to the ton. The fresh oil was of good quality and free from acidity. On May 1 after filtering, this oil was of the best quality, pale golden in color, with the distinct opalescent hue sometimes seen in Mission oils, and free from acidity.

*Pressing No. 20, Jan. 7, 1909:* This pressing was made from fourteen pounds, twelve ounces of the decayed and partially decayed olives sorted out from the Tucson shipment. In order to fill the press, a few rotten Cajons (about two pounds) were included in the test. The object of making this test was to determine the effects of rotten olives on the quality of the oil. The pressing resulted in 1486 cc, or 53.22 gallons of oil to the ton. The fresh oil had quite a bad sour flavor. On May 1, after filtering, this oil had greatly improved. It was a clear golden color. The flavor was fair, with a slight taint of sourness, but not at all rancid, with no acidity.

*Pressing No. 19, Jan. 7, 1909:* Fully ripe, plump fruit was secured from Munger's ranch. Fourteen pounds, twelve ounces were used in the test, and resulted in 1624 cc, or 58.16 gallons of oil to the ton. The quality of the fresh oil was very fine with no acidity. On May 1, after filtering, the oil had cleared into a beautiful pale golden color, with a very fine rich nutty flavor, and no acidity.

*Pressing No. 25, Jan. 14, 1909:* In order to determine the quality of oil made from perfectly green olives, fourteen pounds,

twelve ounces of green olives were picked at the Station Farm and crushed and pressed immediately. The result was 1054 cc, or 37.70 gallons of oil to the ton. The color of this oil when fresh was a bright green, and the acrid taste was noticeable, though not very marked. On May 1, after filtering, the color had changed from bright green to dark green, and the flavor was disagreeable, though but little acidity was noticed.

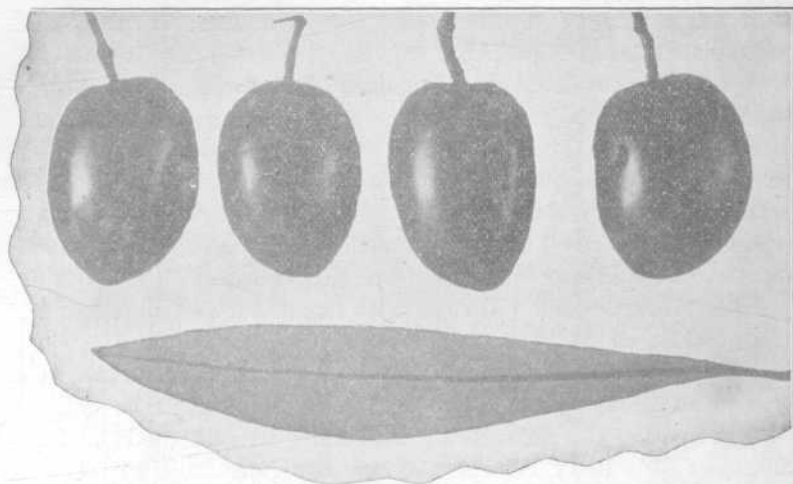


Fig. 3. Mission olives, natural size, from the original trees at San Diego Mission, California.

*Pressing No. 26, Jan. 15, 1909:* Fresh fruit just beginning to turn red was gathered at the Station Farm, and fourteen pounds, twelve ounces were crushed and pressed at once. The result was 1110 cc, or 39.73 gallons of oil to the ton. On May 1, after filtering, this oil was lighter in color than No. 25; the flavor was better, but with a faint "greenish" taste, though not acrid.

*Pressing No. 28, Jan. 16, 1909:* Fruit fully ripe but plump was gathered from the Station Farm. Fourteen pounds, twelve ounces were used in the test, which resulted in 1400 cc, or 50.13 gallons of oil to the ton. On May 1, after filtering, this oil was pale golden in color; flavor rich and nutty; quality the very best; no acidity.

*Pressing No. 27, Jan. 15, 1909:* Fruit was gathered at the Station Farm, dead ripe and much shrivelled on the trees, fourteen pounds, twelve ounces being crushed and pressed at once. The result was 1210 cc, or 43.28 gallons of oil to the ton. On May 1, after filtering, this oil was pale golden and opalescent in color. The flavor was rich and nutty with a very faint musty odor, and no acidity.

*Pressing No. 29, Jan. 16, 1909;* The fruit used in this test was a mixture of different degrees of ripeness, consisting of mixed samples of Nos. 25, 26, 27, and 28, with a few leaves and twigs added and the whole lot somewhat bruised, thus approximating the ordinary run of olives used in some commercial oil mills. Fourteen pounds, twelve ounces were used, and 1480 cc, or 53.00 gallons of oil to the ton secured. It is difficult to explain why a mixture of olives of different degrees of ripeness should yield more oil than any one of the samples alone, but such was the case in this instance. On May 1, after filtering, this oil was greenish-golden in color with fair flavor and no acidity, but with a slight "greenish" taste.

*Pressing No. 32, Jan. 26, 1909:* The fruit for this test was grown on Munger's ranch. It had been made into ripe pickles, but in heating the cans during the sealing process the color had changed to a dirty brown, making them unsalable as pickles. As a good many olives are annually lost in this way, it was decided to determine how much and what quality of oil could be secured from these off-color pickles. The brine was drained off, and thirteen pounds, twelve ounces of the water-charged olives were crushed and pressed at once. As a result, 935 cc, or 35.92 gallons of oil to the ton was secured. On May 1, after filtering, the oil was very clear and pale yellow in color. While the flavor was good, there was a distinct pickle taste which, while noticeable, was not objectionable. The oil was smooth and free from acidity.

*Pressing No. 31, Jan. 25, 1909:* Material for this test consisted of a sample of Mission pomace taken from the refuse heap at Munger's mill. About ten days passed before pressing, during which time it moulded badly. Eight pounds, fourteen ounces of the dry pomace was reground and pressed twice, hot water being used each time. The oil secured amounted to 190 cc

of clear oil, or 11.24 gallons to the ton of dry pomace. On May 1, after filtering, this oil was very dark green in color, and the flavor was very strong and musty, due probably to the mould in the pomace. It was not fit for salad oil.

*Morinello.*

This variety is distinctly an oil olive. The tree grows to a very large size and tends to produce tremendous crops every alternate year. The fruit is medium in size (136 to the pound at the Station Farm) and begins to ripen in December. If not harvested it will hang on the tree without shrivelling and in good condition for oil making till June 1. The great objection to this variety is its unevenness in ripening, many olives being black and soft at one end and green and hard at the other. Examination of a tree on the Station Farm on May 20, showed a larger number of green olives than of ripe ones.

*Pressing No. 21, Jan. 9, 1909:* Fruit was gathered at the Station Farm and carefully sorted, only the perfectly green olives being used in the test. Fourteen pounds, twelve ounces were crushed and pressed at once. The result was 818 cc, or 29.24 gallons of oil to the ton. The fresh oil was bright green in color and very acrid. On May 1, after filtering, the color was deep greenish-golden; flavor poor, with a disagreeable taste and decided acidity.

*Pressing No. 22, Jan. 9, 1909:* The fruit used in this test consisted of the ripe, plump fruit sorted out from Pressing No. 21. It was crushed and pressed the same day and showed a much greater yield of oil than the green fruit. Fourteen pounds and twelve ounces of olives were used, and the amount of oil secured was 1270 cc, or 45.48 gallons to the ton. On May 1, after filtering, the color was deep greenish-golden. The slight acidity was hardly perceptible.

*Nevadillo.*

This variety is medium in size and jet black in color when ripe. It ripens in November and December, and colors fairly uniformly. The tree is large and a vigorous grower, bearing medium sized crops with regularity.

*Pressing No. 6, Dec. 24, 1908:* Thoroughly ripe fruit of this variety was secured from Munger's ranch, on the foothills

near Phoenix. In the test fourteen pounds, twelve ounces were used. The result was 1250 cc, or 44.75 gallons of oil to the ton. The fresh oil was of a bright green color, had a decided "green" taste, and a faint, though distinct, acidity. On May 1, after filtering, the color was a deep greenish-golden. The flavor was fair, though somewhat greasy, and the acidity had entirely disappeared.

*Pendulina.*

This is a French variety and is considered one of the best for oil making. It ripens fairly uniformly during November and December. It is fairly prolific, but there seems to be a good deal of variation in the size of the berries.

*Pressing No. 7, Dec. 28, 1908:* Well ripened fruit was secured from Munger's ranch on the foothills near Phoenix. Five days elapsed between picking and pressing, but the fruit was in very good condition. In the pressing fourteen pounds, twelve ounces were used, and the result was 1170 cc, or 41.84 gallons to the ton. The oil was very bright golden in color, smooth and of very good flavor, with no "greenish" taste, and practically no acidity. On May 1, after filtering, this oil was of the very best quality, bright golden in color, with a distinct and very pleasant flavor, and no acidity.

*Pressing No. 16, Jan. 5, 1909:* The fruit for this pressing was grown on the University Campus at Tucson. About five days intervened between picking and pressing. The fruit was ripe and slightly shrivelled. In the test seven pounds, six ounces were used. The result was 750 cc, or 53.68 gallons to the ton. This oil was of the very finest quality as it came from the press. On May 1, after filtering, the quality was very fine, color very clear light golden. The flavor was good.

*Razza.*

The Razza is one of the noted oil-press olives of Italy. In the Salt River Valley the tree grows to large size and bears heavy crops. It is black when ripe and medium in size, 140 weighing a pound. It ripens irregularly from late December till spring, and will hang on the tree in good condition till May 1. A very good oil-olive for Arizona.

*Pressing No. 23, Jan. 11, 1909:* The fruit for this test was grown at the Station Farm, all ripe but a few with green ends, and some slightly shrivelled from lack of irrigation. Fourteen pounds, twelve ounces were used in the test, which resulted in 1336 cc, or 47.84 gallons of oil to the ton. The fresh oil was a light greenish-golden in color and had very little acidity. The oil cleared up beautifully before filtering. Quality very good, pleasant flavor, no acidity. On May 1, after filtering, the color was rich golden with very little greenish tint. The quality and flavor were of the very finest.

*Rubra.*

The Rubra is a French variety used chiefly for oil making. It is small in size and bluish-black when ripe. It is in condition to pick for oil from December 1 to February 1, when the fruit begins to fall rapidly. The tree is only fairly productive.

*Pressing No. 12, Dec. 29, 1908:* The fruit was gathered at the Station Farm, perfectly ripe but not shrivelled. Fourteen pounds, twelve ounces were used in the test, the fruit being crushed and pressed immediately after picking. The result was 670 cc, or 24.00 gallons of oil to the ton. This was much the lowest yield of oil secured from any of the samples. The fresh oil was bright yellow, of good flavor, and practically free from acidity. After being filtered, on May 1, the color was a beautiful deep greenish-golden. The quality was fair, but with a very slight bitter taste.

*Uvaria.*

This variety was introduced from France. It ripens early, usually in November. The fruit grows in clusters, colors evenly, and all the olives are ready to pick at one time. The fruit will not hang on the trees after Christmas. It is medium in size with a very large seed. The trees bear large crops regularly, but the fruit is somewhat difficult to pick on account of the firmness of attachment and softness of the flesh. For this reason many of the olives will mash in the picker's hand, and hence must be crushed and pressed immediately.

*Pressing No. 3, Dec. 21, 1908:* The fruit was gathered at the Station Farm, and twelve pounds, twelve ounces were crushed and pressed at once. The result was 760 cc, or 31.44 gallons of

oil to the ton. As the oil came from the press it was of fair quality, but with a taste suggesting green olives though the fruit used was perfectly ripe. There was also a slight acidity. On May 1, following, the "greenish" flavor was still noticeable, though the acidity was lacking. The color of the filtered oil was pale golden.

#### COMMERCIAL PRESSINGS.

It was found impracticable to secure sufficiently large samples of oil with the Buchner press when the oil from the different pressings was kept separate. Munger Bros., therefore offered the use of their large press of one ton capacity and 490 pounds per square inch maximum pressure; together with sufficient olives for the work. Four pressings were made of each of four varieties, viz; Columbella, Manzanillo, Mission, and Nevadillo. The oil from each pressing was kept separate, and after settling clear was filtered and stored in five ounce bottles for observations on keeping quality. The oil from the first pressing was highest in color and of best quality, and graded uniformly toward the last pressing, which was darkest in color and of poorest quality.

- Columbella:* 1st pressing, excellent flavor, mild, like Tucson Mission.  
 2nd pressing, nearly equal to first pressing.  
 3rd pressing, good.  
 4th pre sing, good.
- Manzanillo:* 3rd pressing, strong flavor, edible.  
 4th pressing, greasy flavor, edible.  
 5th pressing, greasy flavor, edible.
- Mission:* 1st, 2nd, 3rd, and 4th pressings, lost.
- Nevadillo.* 1st pressing, pronounced flavor, a good oil.  
 2nd pressing, better flavor, a good oil.  
 3rd pressing, strong flavor, edible.  
 4th pressing, inferior flavor, edible.

TABLE I.—SUMMARY OF PRESS TESTS OF VARIETIES OF OLIVES FOR OIL 1908-9, USING BUCHNER PRESS AT STATION FARM.

Variety	No.	Date	Source	Condition as regards ripeness, etc.	Weight of olives used in test	Amount of oil secured in cc.	Gallons of oil to ton of olives	Pounds of olives required for 1 gal. oil
					lbs. oz	cc		
Ascolano	4	Dec 22, '08	Sta. Farm	Half ripe, beginning to turn red.	12- 9	600	25.20	79
Ascolano	9	Dec. 29, '08	Sta. Farm	Dead ripe, beginning to shrivel	14-12	1070	38.29	52
Cajon	14	Jan. 4, '09	Tucson	Dead ripe, somewhat shrivelled	7- 4	390	28.40	70
Columbella	24	Jan. 11, '09	Sta. Farm	Half ripe, red	14-12	1101	39.39	51
Correggiola	5	Dec 22, '08	Sta. Farm	Mostly plump ripe, green on one end	12-11	1060	44.12	45
Correggiola	30	Jan. 18, '09	Sta. Farm	Ripe, plump	14-12	1436	51.39	39
Grossaia	8	Dec. 28, '08	Munger's	Plump, ripe	14-12	1175	42.01	47
Manzanillo	1	Dec. 17, '08	Sta. Farm	Dead ripe, plump	12-12	840	34.74	57
Manzanillo	2	Dec. 18, '08	Sta. Farm	Dead ripe, plump	11-12	780	35.08	57
Mission	11	Dec. 29, '08	Sta. Farm	Plump, ripe	14-12	1468	50.08	40
Mission	18	Jan. 6, '09	Tucson	Dead ripe, 3-4 of them shrivelled	15-0	1530	53.84	37
Mission	20	Jan. 7, '09	Tucson	Dead ripe, shrivelled, many rotten	14-12	1486	53.22	37
Mission	19	Jan. 7, '09	Munger's	Dead ripe, plump	14-12	1624	58.16	34
Mission	25	Jan. 14, '09	Sta. Farm	Perfectly green	14-12	1054	37.70	53
Mission	26	Jan. 15, '09	Sta. Farm	Half ripe, red	14-12	1170	39.73	50
Mission	28	Jan. 16, '09	Sta. Farm	Ripe, plump	14-12	1400	50.13	40
Mission	27	Jan. 15, '09	Sta. Farm	Dead ripe, shrivelled	14-12	1210	43.28	46
Mission	29	Jan. 16, '09	Sta. Farm	Above four, mixed	14-12	1480	53.00	38
Mission	32	Jan. 26, '09	Munger's	Ripe pickles, off color	13-12	935	35.92	56
Mission	31	Jan. 25, '09	Munger's	Mouldy pomace	8-14	190	11.24	178
Morinello	21	Jan. 9, '09	Sta. Farm	Perfectly green	14-12	818	29.24	68
Morinello	22	Jan. 9, '09	Sta. Farm	Ripe, plump	14-12	1270	45.48	44
Nevadillo	6	Dec. 24, '08	Munger's	Plump, ripe	14-12	1250	44.75	44
Pendulina	7	Dec. 28, '08	Munger's	Plump, ripe	14-12	1170	41.84	48
Pendulina	16	Jan. 5, '09	Tucson	Dead ripe, mostly plump	7- 6	750	53.68	37
Razza	23	Jan. 11, '09	Sta. Farm	Ripe, plump	14-12	1336	47.84	42
Rubra	12	Dec. 29, '08	Sta. Farm	Plump, ripe	14-12	670	24.00	83
Uvaria	3	Dec. 21, '08	Sta. Farm	Dead ripe, plump	12-12	760	31.44	63

TABLE II.—ANALYSES OF OLIVES.

By W. H. Ross.

VARIETY	Moisture at 110° C.	Sp. gr. of oil at 17.5° C.	Ether ex- tract(oil)in fresh material	Gals. of oil per ton of fresh olives (*)
Ascolano olives picked Jan. 29 . . . . .	70.26%	.....	13.64%	.....
Correggiola olives picked Jan. 29 . . . . .	52.00	.....	21.89	.....
Correggiola olives picked Apr. 20 . . . . .	54.94	.....	22.51	.....
Columbella olives picked Jan. 29 . . . . .	64.06	.....	16.52	.....
Columbella olives picked Apr. 20 . . . . .	63.89	.....	17.18	.....
Mission olives picked Apr. 20 . . . . .	65.00	.....	14.66	.....
Razza olives picked Jan. 29 . . . . .	52.22	.....	22.60	.....
Mission olives, Pressing No. 19 . . . . .	51.32	.9163	21.06	55.19
Mission pomace, Pressing No. 19 . . . . .	27.39	.....	6.16	.....
Mission olives, Pressing No. 29 . . . . .	56.34	.9168	20.08	52.58
Mission pomace, Pressing No. 29 . . . . .	26.53	.....	7.06	.....
Mission pickles, Pressing No. 32 . . . . .	64.86	.9170	17.24	45.14
Pomace from Mission pickles, Pressing No. 32 . . . . .	32.61	.....	4.49	.....
Olive pomace from Munger's press, Pressing No. 31 . . . . .	20.10	.9148	7.53	19.77
Olive pomace from Munger's re- pressed Pressing No. 31 . . . . .	24.16	.....	4.00	.....

\* Samples in some instances defective; results therefore not entirely consistent with press tests.

#### THE BEHAVIOR OF OLIVE OILS IN HOT AND IN COLD WEATHER.

In connection with the manufacture of oil in the Southwest it is of interest to know the behavior of the different pressings described above with our extremes of temperature. For this purpose the samples, sealed in five-ounce bottles, were kept under observation for the period of a year. On May 1, 1908, four months after making, the samples were carefully observed with reference to appearance and quality, being at that time clear without exception but varying as to acidity and flavor according to their derivation.

The samples after examination were left in the press room for three months, exposed to the extreme summer temperatures of Salt River Valley, ranging up to 112 degrees in the shade. For three months longer they remained at a more moderate temperature in the laboratory at Tucson, being then again examined for flavor with reference to their endurance of the six months hot season just passed. Their condition Nov. 15, is shown in the subjoined table and in most cases was most satis-

factory. Even such oils as No. 20, made from partly rotten olives, came through the season not rancid and in good flavor. No. 31, from mouldy pomace, though not rancid, was distinctly acrid and of a strong musty flavor. This hot weather test clearly indicates that if cleanliness is diligently observed in the manufacture of olive oils, they are no more perishable than many other carefully prepared food products.

The tendency of olive oils to solidify during cold weather is also a matter of commercial interest. Olive oil is ordinarily stated by European observers to solidify at about 2 degrees Centigrade, or 36 degrees Fahrenheit. Oils from different sources however, vary greatly in this respect, some of them becoming partly or quite solid at considerably higher temperatures than this. Such oils, exposed for sale in glass bottles during cool weather, are likely to become clouded with white flocks or crystals, or may even solidify, by reason of the separation at lower temperatures of the higher fat-acids contained in varying proportions in olive oils. This detracts from appearances and often leads to unjust suspicion as to the purity of the clouded oils.

On November 15, the samples after tasting were placed in an ice box in order to equalize thermal conditions and exposed to gradually falling winter temperatures in an open porch. In all cases except one or two samples of Manzanillo, all these oils were then clear at a beginning temperature of 74 degrees F. As the weather became cooler, however, certain oils became turbid, and in some instances solid. Others remained entirely clear. The results, with times and temperatures of observation are also shown in the table, from which it appears that the most satisfactory of our oils as to fluidity in cold weather is Mission. Manzanillo in particular solidifies easily, being most quickly converted, of the oils observed, into a semi-solid state on cooling, even at a temperature between 40 and 50 degrees F. Commercial oils from California named Sylmar, McNally, and American, remained fluid equally well with our Mission.

TABLE III.—BEHAVIOR OF OLIVE OILS DURING HOT AND COLD WEATHER.

Changes in quality May 1—Nov. 15, 1909				Changes in fluidity Nov. 15,—Jan. 6, '10		
Variety	No.	Condition May 1, '09	Condition Nov. 15, '09	Nov. 15, 74° F.	Dec. 4 40° F.	Jan. 6, 29° F.
Ascolano . . .	4	Greenish-golden, pleasant flavor, not acrid	Very poor flavor, edible	Clear..	Flocculent ppt.	Solid. . . . .
Ascolano . . .	9	Greenish-yellow, pleasant flavor, not acrid	Mild flavor, good . . . . .	Clear..	Flocculent ppt.	Solid. . . . .
Cajon . . . . .	14	Greenish-golden, walnut flavor, not acrid	Mild flavor, very good..	Clear..	Clear. . . . .	Semi-solid. . .
Columbella . .	24	Greenish-golden, variety flavor, not acrid..	Very good flavor . . . . .	Clear..	Flocculent ppt.	Semi-solid. . .
Correggiola . .	5	Greenish-yellow, good flavor, not acrid . . .	Poor flavor, edible. . . . .	Clear..	Heavy ppt. . . .	Solid. . . . .
Correggiola . .	30	Golden color, good flavor, not acrid. . . . .	Good flavor. . . . .	Clear..	Flocculent ppt.	Semi-solid. . .
Grossala . . . .	8	Greenish-golden, fair flavor, slightly acrid..	Strong flavor, good . . . .	Clear..	Slight turbidity	Semi-solid. . .
Manzanillo . . .	1	. . . . .	Very good flavor . . . . .	Turbid	Flocculent ppt.	Semi-solid. . .
Manzanillo . . .	2	Pale yellow, greasy flavor, not acrid . . . . .	Strong flavor, good . . . .	Turbid	Flocculent ppt.	Semi-solid. . .
Mission . . . . .	11	Pale golden, nutty flavor, not acrid . . . . .	Good flavor, but oily . . . .	Clear..	Clear. . . . .	Clear . . . . .
Mission . . . . .	18	Pale golden, best flavor, not acrid . . . . .	Superior, mild flavor. . . . .	Clear..	Clear. . . . .	S'l't turbid'y
Mission . . . . .	20	Clear golden, slightly sour, not acrid . . . . .	Good flavor. . . . .	Clear..	. . . . .	. . . . .
Mission . . . . .	19	Pale golden, nutty flavor, not acrid . . . . .	Very good flavor . . . . .	Clear..	Slight turbidity	Floc. ppt. . . .
Mission . . . . .	25	Dark green, disagreeable, slightly acrid. . . .	Good, mild flavor. . . . .	Clear..	Slight turbidity	Clear. . . . .
Mission . . . . .	26	Lighter green, greenish flavor, not acrid . . .	Good, pronounced flavor	Clear..	Clear . . . . .	Clear. . . . .
Mission . . . . .	28	Pale golden, nutty flavor, not acrid . . . . .	Superior, mild flavor. . . . .	Clear..	Slight turbidity	Floc. ppt. . . .
Mission . . . . .	27	Pale golden, nutty flavor, not acrid . . . . .	Very good flavor . . . . .	Clear..	Flocculent ppt.	Floc. ppt. . . .
Mission . . . . .	29	Greenish-golden, greenish flavor, not acrid.	Good flavor. . . . .	Clear..	Slight turbidity	S'l't turbid'y
Mission . . . . .	32	Pale yellow, pickle flavor, not acrid. . . . .	Pickle flavor, good. . . . .	Clear..	Clear. . . . .	Clear. . . . .
Mission . . . . .	31	Dark green, strong musty flavor. . . . .	Strong musty flavor. . . . .	Clear..	. . . . .	. . . . .
Morinello . . . .	21	Greenish-golden, disagreeable, acrid . . . . .	Poor flavor . . . . .	Clear..	Flocculent ppt.	Solid. . . . .
Morinello . . . .	22	Greenish-golden, slightly acrid . . . . .	Poor flavor . . . . .	Clear..	Clear. . . . .	Solid. . . . .
Nevadillo . . . .	6	Greenish-golden, greasy flavor, not acrid. . . .	Very good flavor . . . . .	Clear..	Clear. . . . .	Semi-solid. . .
Penduliza . . . .	7	Bright golden, pleasant flavor, not acrid. . . .	Poor flavor . . . . .	Clear..	Flocculent ppt.	Solid. . . . .
Pendulina . . . .	16	Pale golden, excellent flavor, not acrid . . . .	Good flavor, but oily. . . . .	Clear..	Slight turbidity	Solid. . . . .
Razza . . . . .	23	Greenish-golden, excellent flavor, not acrid	Good flavor. . . . .	Clear..	Flocculent ppt.	Semi-solid. . .
Rubra . . . . .	12	Greenish-golden, bitter flavor . . . . .	Poor flavor . . . . .	Clear..	Clear. . . . .	Semi-solid. . .
Uvaria . . . . .	3	Pale golden, greenish flavor, not acrid. . . . .	Very good flavor . . . . .	Clear..	Slight turbidity	Semi-solid. . .

## CONCLUSIONS DRAWN FROM EXPERIMENTS.

Many varieties of olives, when grown under Arizona conditions are well adapted to oil making, and when properly made from them the oil may be of the very finest quality. The pronounced acidity sometimes noticed in Arizona oils, and objected to by many consumers, is not the fault of the olive alone. The blame for this type of oil rests rather with those manufacturers who do not take the proper precautions to avoid this acrid taste.

Among the varieties tested, those best suited for oil making are *Mission*, *Correggiola*, *Pendulina*, *Razza*, and *Nevadillo*. *Correggiola* oil when fresh sometimes has an acrid taste, due probably to the green ends of the berries, but if the oil is properly made, this taste will be so slight that it will pass away entirely after standing two months.

The quantity of oil secured in these tests indicates that the Arizona olive is not below the California product in recoverable oil content. If we average the figures collected by G. W. Shaw \* from eight representative oil mills of California, we find that they obtained on an average of thirty-five gallons of oil to the ton of olives. On the other hand, if we select the fourteen tests in this series which were made of oil olives, we find that an average of 48.43 gallons of oil to the ton was secured, or 13.43 gallons to the ton more than the California average. This increase is of course largely due to the extra efficiency of the Buchner press. A comparison of the size of olives grown in California and Arizona is given in the following table. The figures for California are taken from the California Experiment Station Report, 1895-'96 and 1896-'97, page 206; and California Station Bulletin 123, page 34. The observations on Arizona olives were made by E. E. Free, V. A. Clark and W. H. Ross. The table is given here more as a record of present indications than as a final verdict in regard to the status of Arizona-grown olives.

\*California Station Bulletin No. 158, page 25.

TABLE IV.—COMPARISON OF ARIZONA AND CALIFORNIA OLIVES.

Variety	No. of olives to 100 grams		Variety	No. of olives to 100 grams	
	Arizona	California		Arizona	California
Ascolano.....	9	13	Morinello.....	36	69
Columbella.....	35	27	Nevadillo.....	23	36
Correggiola.....	39	56	Pendulina.....	34	35
Grossaia.....	36	43	Razza.....	37	47
Manzanillo.....	16	23	Rubra.....	41	45
Mission.....	22	25	Uvaria.....	37	35
			Average.....	30	38

As the same variety of olive varies widely in size of berry and oil content when grown under different conditions, it is advisable to deal in averages of as large a number of analyses as possible. The figures for Arizona in the table are averages from a much smaller number of analyses than the California figures.

Judging from olive literature, the impression prevails that oil secured by a third and fourth pressing of the pomace after the addition of warm water is necessarily of such a low grade as to be suitable only for fuel or soap manufacture.

It is also a common belief among oil men that the so-called "virgin oil" or first-pressing oil has poorer keeping qualities than that from the second pressing. All this may be true under ordinary methods of manufacture, but in this connection the author wishes to emphasize three facts brought out by the experiments above described:

1. The oil from all the pressings (in some cases five pressings were made) necessarily including the seed oil, was mixed together without appreciably lowering the quality of the product.
2. Practically all of the oils retained their high quality for one year at least, notwithstanding the admixture of the much condemned seed oil and the unusually trying temperature conditions under which they were placed.
3. It was not necessary to age these oils for a year as is commonly done in commercial mills. Most of the samples were ready for market four months after date of manufacture. In fact if a force filter had been resorted to, some of the Mission oils might have been bottled up within a week after pressing.

It seems, therefore, safe to say that all the oil which it is possible to extract from ripe olives with a pressure of 640 pounds per square inch may be mixed together with safety, *provided*, all the pressings are made in one day, the oil is not allowed to stand with the black juice for more than a few minutes, and very cleanly methods are used.

As a further result of the press tests the author concludes that the acidity so objectionable in oils is chiefly due to the admixture of green olives or olives which have matured at one end only. Aside from acidity there are other bad flavors encountered in commercial oils. After visiting a number of southwestern oil mills the author ascribes these bad flavors to the following causes: (a) Careless picking whereby the berries are broken and a part of the oil set free, such free oil rapidly absorbing odors from the soil, musty sacks, etc., until pressed; (b) Allowing a long time to elapse between picking and pressing, thus allowing mold to develop on the broken berries; (c) The use of filthy and rancid press cloths, the fibers of the cloth permitting the oxygen of the air to come into intimate contact with the absorbed oil with consequent rancidity; (d) Lack of dispatch in the pressing process and in separating the oil from the black press liquid; and (e) over-filtration. Wherever oil is passed through filter paper in the open it is brought into more or less intimate contact with oxygen, with deleterious effects. Consequently the process of settling and racking should be relied upon as much as possible for the clarification of the oil.

#### ACKNOWLEDGEMENTS.

The author wishes to take this opportunity to thank the Munger Brothers, of Olivet Ranch, for the donation of olives, and especially Mr. Milton Munger for cordial cooperation and valuable assistance.

Of the Station Staff, he also wishes to thank Dr. W. H. Ross, who made the chemical analyses presented herewith, and Dr. A. E. Vinson, who assisted in testing and who did the work represented in Table III.