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DIVISION OF HORTICULTURE

Improved Methods of Utilizing the Magnolia Fig

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Steps in the prevailing commercial method of processing Magnolia figs have been carefully examined in the laboratory with the view of possible improvement. A method of canning in light sirup adapted for use with the Magnolia fig is presented in detail. Forty per cent glucose to sixty per cent cane sugar is recommended as the most satisfactory ratio for candying figs. Sulfur dioxide at a concentration of 1000 parts per million was found to keep figs at the hard-ripe stage for nine months. Higher concentrations kept such figs for over a year. The effect of washing to remove the sulfur dioxide is discussed.

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IMPROVED METHODS OF UTILIZING THE MAGNOLIA FIG

H. M. REED

Since its beginning the Texas fig industry has been concerned chiefly with the manufacture and marketing of fig preserves. When fig production was still comparatively small the preserving plants had no difficulty in finding sufficient markets for their products, so that the problem of what to do with surplus figs was of no particular importance. As the bearing acreage of Magnolia figs increased, overproduction occurred with serious consequences to the industry (8). The results of overproduction were felt by the growers in decreased returns for their figs and by the preserving plants in the necessity for widened markets and in the loss of figs due to spoilage before they could be preserved.

It is probable that the problems concerned with a surplus can be greatly relieved by manufacturing a greater variety of fig products. This should make possible the utilization of figs that would normally be wasted under the present system of manufacture. The investigations which are reported in this publication were made to assist in solving the problems of surplus.

Throughout this publication the terms excellent, good, fair, and poor are used to describe the quality of the appearance, texture, and flavor of the products under experiment.

When the products were judged for appearance, the color, uniformity of size, and freedom from blemishes were taken into account. The canned fruit was considered to have a good texture when it was tender but firm, as judged by cutting with a spoon, or by eating it. The more closely the flavor of the product resembled that of the fruit from which it was made, the better it was considered to be.

Since the terms used to describe the quality of the products do not represent exact quantitative measurements, they are chiefly of value when used in a comparative sense. Repeated observations by as many as nine individuals have been relied upon to make the comparative results reliable.

FIG PRESERVES

Present Methods

The method of making Magnolia fig preserves in Texas has been practically the same from the time the industry began up to the present time. The procedure, with a few variations by individual preserving plants, is as follows: The figs are brought in from the orchards at the hard-ripe stage of maturity. At this degree of ripeness, they are very firm and can be put through the preserving process with little trouble from cooking to pieces. The figs are peeled by being passed through a boiling solution of commercial sodium hydroxide of approximately 2 per cent concentration. This form of lye is most commonly used in the canning industry for peeling fruits.

They are then rinsed in fresh water, and the stem and any peeling which remains are trimmed from the fruit by hand.

About one-half as much cane sugar as the weight of peeled figs is added to some water in large open kettles. This mixture is brought to a boil with constant stirring until a sirup of 30-38° Baume' is obtained. When the fruit is inclined to be soft it is added to a heavier sirup than when the fruit is firm. After the prepared figs have been added to the boiling sirup, boiling is continued until they become translucent and the sirup reaches the desired density. The heavy preserves are finished in sirup of about 24° Baume' and the breakfast preserves in sirup of about 18° Baume'. The Baume' determinations are made by means of a hydrometer at frequent intervals during the cooking process while the sirup is boiling hot. The time required for cooking is 40 minutes to 2 hours.

When cooking is completed, the figs are cooled by circulating water through the jackets of the kettles, and where possible they are allowed to stand in the kettles for several hours to permit them to take up the sirup and become plump. Finally they are packed by hand in tin or glass containers and exhausted* until the temperature of the figs reaches 140° to 160° F. The containers are sealed and then sterilized at 190° to 212° F. for 15 to 50 minutes, the length of time depending upon the type and size of the container. The sterilized containers are cooled in water to approximately 120° F. Heating and cooling of the glass containers are done gradually to prevent them from breaking.

Effect of the Concentration of Lye on Its Peeling Efficiency

Tests were made to determine the effect of the concentration of lye on its peeling efficiency with Magnolia figs. Only hard-ripe figs were used and these were graded for uniformity of size and quality. They were divided into lots of 30 to 40 figs, placed in a wire basket, and dipped into 2, 5, 10, 15, and 25 per cent boiling commercial-lye solutions for different intervals of time. After the dipping treatment, the figs were rinsed in fresh water and examined immediately. The examination was first made independently by two observers on the basis of individual figs in each lot. Final observations were recorded by agreement of the two observers after examining each lot a second time. When the dipping solution removed practically all of the skin without eating into the flesh, the treatment was considered "very good." When less of the skin was removed, the results were recorded as "good," "not quite enough," or "not enough," depending upon the amount of skin removed. When pitting of the flesh occurred the results were recorded as "very slightly too much," "slightly too much," or "too much," depending upon the severity of the treatment.

*"Exhausting" is the term used in canning to express the action of heating the container and its contents before sealing to provide a partial vacuum in the container after it is sealed, sterilized, and cooled.

The tests with 2 and 5 per cent lye solutions were repeated the next season and an additional test was made with a 1 per cent lye solution. The results as given in Table 1 show that a slightly longer dip was

Table 1. Effect of concentration of lye and of time on peeling efficiency

Year of test	Per cent lye	Time dipped seconds	Observations
1933	1	30	not quite enough
1933	1	40	very good
1933	1	50	very slightly too much
1933	1	60	slightly too much
1932	2	30	not quite enough
1932	2	35	very good
1932	2	40	very good
1932	2	45	slightly too much
1932	2	50	too much
1933	2	30	very good
1933	2	35	very good
1933	2	40	very slightly too much
1933	2	45	slightly too much
1932	5	20	not quite enough
1932	5	25	very good
1932	5	30	very slightly too much
1932	5	35	too much
1933	5	20	very good
1933	5	25	very slightly too much
1933	5	30	slightly too much
1933	5	35	too much
1932	10	15	not enough
1932	10	20	very good
1932	10	25	good
1932	10	30	too much
1932	15	10	not quite enough
1932	15	15	very good
1932	15	20	too much
1932	20	10	not quite enough
1932	20	15	very good
1932	20	20	slightly too much
1932	25	10	not quite enough
1932	25	15	too much

required with the 2 and 5 per cent solutions in 1932 than with the same lye concentrations in 1933. They also show that the 1 and 2 per cent solutions with the proper length of dip are just as effective in peeling the figs as the higher concentrations, and have the additional advantage of providing a longer interval between the period that gives good results and the period that is too severe.

Effect of Acid Dip on Lye-Peeled Figs

At the stage of ripeness used for preserving, the Magnolia fig has an opening at the blossom end that can very easily permit the entrance of the lye solution into its interior during the scalding process. While the rinsing process probably removes most of the lye from the figs, there is a possibility that a small amount may remain in the fruit and affect the quality of the preserves.

To test this possibility, Magnolia figs at the hard-ripe stage were graded for uniformity of quality and divided into two portions containing enough figs to make twelve cans of preserves from each portion.

One lot was made into heavy preserves by the regular process. The second lot was scalded in the 2 per cent lye solution, rinsed in fresh water, and then dipped in a 0.5 per cent hydrochloric acid solution, and finally rinsed again in fresh water. The figs were then trimmed and preserved as with the first lot.

It was found that the acid dip made the figs more difficult to trim by causing the remaining skin around the stem end of the fruit to adhere more tightly. For this reason it was more practical to dip the figs in the acid solution after instead of before trimming them.

Observations were made by two observers immediately after the figs had been preserved, and on the canned samples after about two weeks. A third observation was made on the samples by one individual after they had been canned about 7 months.

The canning tests were repeated the following season, and at this time samples of figs were withdrawn from the regular lye-peeled figs and from those which had been lye-peeled and acid-dipped. Colorimetric pH determinations made with Brom phenol blue indicator on the juice expressed from the sample, and on the juice from fresh untreated figs showed that the pH of the juice from the regularly lye-peeled figs was very slightly higher. The remaining figs from these tests were made into heavy-sirup preserves. Examination of these preserves was made by four individuals two months after canning. The pH on the sirup from the canned preserves which had been made from the acid-dipped figs was very slightly lower than on the sirup from the canned preserves made by the regular method.

In all cases, the preserves made from the acid-dipped figs were slightly brighter in appearance and of slightly better taste than those that were preserved by the regular method.

A Modified Dip for Fig Preserves

The process now used in making fig preserves was modified by first removing the stems of the figs and then dipping them in a boiling 2 per cent sodium bicarbonate (baking soda) solution for 30 seconds and rinsing in water. After this treatment the regular preserving process was followed to make twelve cans of preserves.

Examinations were made by two observers immediately after preserving and again on the canned samples about one month after preserving. The preserves were found to be as good in texture and flavor as those made from lye-peeled figs, although they were less attractive in appearance in that they were darker in color and the figs that had skin blemishes such as leaf scars and rust spots retained them after they were preserved.

A similar test was conducted one year later. The figs used were of better quality and the resulting preserves were more attractive in appearance than those of the previous year, but were darker in color than the preserves which had been made from lye-peeled figs.

The advantage of the modified method is that the preserves are cheaper to produce because hand trimming is simplified to merely removing the stem; there is less actual loss in weight of fruit; and, since the sodium bicarbonate removes only the outer portion of the skin, slightly riper figs can be used without danger of breaking up in the preserving process.

CANNING MAGNOLIA FIGS IN LIGHT SIRUP

Some varieties of figs, as, for example, the Kadota, are canned in a light sirup without being peeled (4). In general, the method is to give the figs a short blanch in hot water or steam and then place them in cans. The fruit is covered with sirup and the cans are sealed and sterilized. The actual cooking of the fruit occurs during sterilization.

This method has the advantages of a lower cost of production than canning in heavy sirup and of providing a product that more nearly resembles the fresh fig in flavor. A series of tests was made to establish a method for making a similar product from the Magnolia fig.

Preliminary Tests

A study of the suitability of the Magnolia to Kadota-fig-canning methods included the following: to determine (1) the effect of blanching, (2) the most pleasing degree of sweetness, and (3) the most effective length of sterilization. The figs used in the tests were at the hard-ripe stage of maturity. Observations were made a few weeks after canning by seven people. About six months later samples were again examined by a single observer to note any change which might have occurred during that time.

From a study of the results, it was found that water was more effective than steam as a blanching medium for removing the green taste and improving the texture. Figs canned in 50° and in 60° Brix (27.3° and 32.5° Baume′) sirup had the most pleasing degree of sweetness for bringing out the fig flavor. When these canned samples were opened and examined, the sirup had become diluted by the juice in the figs to 21°-31° Brix (11°-17° Baume′). The relation between degrees Brix and degrees Baume′ is shown in Table 2.

On the average, for figs at the hard-ripe stage of maturity, a two-hour cook in sealed No. 1 tall cans at boiling-water temperature was the most effective. Less than two-hour cooks left a green taste in the figs and they were usually too hard and tough in texture.

Magnolia figs packed in this way have a rough skin, which becomes more apparent after they have been canned for several months. They have a rather poor texture, and lack a pronounced fig flavor.

Table 2. Relation between degrees Brix and degrees Baume'*

Degrees Brix	Degrees Baume'	Degrees Brix	Degrees Baume'
20	11.10	50	27.28
25	13.84	55	29.90
30	16.57	60	32.49
35	19.28	65	35.04
40	21.97	70	37.56
45	24.63	75	40.03

*From official methods of analysis of the Association of Official Agricultural Chemists, Washington, D. C.

Effect of Increased Acidity on Flavor

Many fruits owe their pleasing flavor to a natural acidity. Among the fruits, figs are relatively low in acid content (2).

To test the effect of increasing the acidity of canned Magnolia figs seven No. 10 cans of fruit which had previously been canned with water were drained and the juice made up to a 50° Brix (27.3° Baume') sirup with cane sugar. The sirup was divided into three portions. To the first 0.2 per cent citric acid was added on the basis of sirup solids, to the second 0.25 per cent, and to the third 0.5 per cent citric acid was added. The drained figs were then re-canned in No. 1 tall cans with the use of acidified sirups. The cans were exhausted 5 minutes in steam, sealed, and sterilized 20 minutes at boiling-water temperature.

From numerous observations made on these samples by different individuals it was noted that the addition of citric acid materially improves the flavor, and that while 0.25 per cent acid did not seem to be sufficient, the figs canned with the 0.5 per cent citric acid in the sirup were too acid in flavor. A similar test using 0.35 per cent citric acid based on the weight of sirup solids gave a very effective acidity from the standpoint of flavor.

Additional tests in which fresh figs were canned with 0.35 per cent citric acid in the sirup and with no acid in the sirup again pointed out the improvement in flavor due to the presence of the acid.

The method of basing the percentage of acid on the weight of sugar was used because in the preserving plants the weight of sugar used to make up the sirup is definitely known, whereas the amount of water used to make the sirup and the weight of figs used per batch are only approximately known.

Removing the Roughness from the Skin

It was found that by using a modification of the lye-scalding process, the roughness of the skin of the Magnolia figs can be removed without entirely removing the skin. In contrast to the action of sodium hydroxide in the lye-peeling process, which separates the entire skin of the fruit from the flesh, the modified method removed enough of the outside layer of the skin to eliminate the objectionable roughness.

The figs were picked and graded for two stages of maturity, hard-ripe and ripe. The latter stage represents about one day more of tree ripening than the hard-ripe figs. During this time the fig becomes less green in color and less firm in texture and is at the stage of ripeness most generally preferred for eating in the fresh state.

By means of a wire basket small lots of the figs were dipped into boiling solutions of 2 per cent sodium hydroxide, 2 per cent sodium bicarbonate, and 2 per cent potassium carbonate for varying periods of time and the effect on the skin noted immediately after dipping and rinsing the samples in fresh water. Similar tests were made with 10 per cent solutions of the same compounds at room temperature (80° F.). Examination of the samples was made by two independent observers judging the individual figs in each lot and reaching a final conclusion by agreement after a second observation. In cases where there was any doubt as to the effectiveness of the dip, testing was done by rubbing the figs across the lips and noting whether they felt smooth or rough. The results of the dipping tests are presented in Table 3.

From the standpoint of effectiveness and economy the boiling 2 per cent sodium bicarbonate solution proved to be very satisfactory. The hard-

Table 3. Effect of various solutions on removing roughness of skin

Dipping solution*	Hard-ripe figs		Ripe figs	
	Time of dip (seconds)	Observation	Time of dip (seconds)	Observation
2% Sodium hydroxide	2	effective	5	removed all the skin
2% Sodium hydroxide	4	removed all the skin	10	removed all the skin
2% Sodium hydroxide	5	removed all the skin	30	removed all the skin
2% Sodium bicarbonate	5	no effect	15	effective
2% Sodium bicarbonate	10	no effect	30	removed all the skin
2% Sodium bicarbonate	15	no effect	45	removed all the skin
2% Sodium bicarbonate	25	effective		
2% Potassium carbonate	5	no effect	15	effective
2% Potassium carbonate	15	no effect	30	removed all the skin
2% Potassium carbonate	20	effective	45	removed all the skin
2% Potassium carbonate	25	removed all the skin		
10% Sodium hydroxide	30	removed all the skin	30	effective
10% Sodium hydroxide	45	pitting of flesh	45	removed all the skin
10% Sodium hydroxide	60	pitting of flesh	60	removed all the skin
10% Sodium bicarbonate	30	no effect	30	effective
10% Sodium bicarbonate	45	no effect	45	removed all the skin
10% Sodium bicarbonate	80	no effect	80	removed all the skin
10% Potassium carbonate	30	effective	30	removed all the skin
10% Potassium carbonate	45	removed all the skin	45	removed all the skin
10% Potassium carbonate	90	removed all the skin	90	removed all the skin

*2% Solutions at boiling temperature, 10% solutions at 80° F.

ripe figs required a longer dipping time than the ripe figs. In general, a dip of 15 to 30 seconds in a boiling 2 per cent sodium bicarbonate solution, the length of time depending upon the maturity of the figs, was effective in removing the roughness of the skin.

Effect of Blanching on Texture

As has already been pointed out, water seemed to be more efficient than steam as a blanching medium in the preliminary tests. A combination of the sodium bicarbonate dip and the boiling-water blanches were tried for different lengths of time to determine a method for producing canned figs of good texture with hard-ripe and ripe fruit. From the standpoint of a canned fruit the texture of the figs was considered to be poor before the treatments because they were too firm and tough.

After the figs had been dipped in the boiling bicarbonate solution for the required length of time, they were rinsed and placed in the boiling water for 1, 2, 3, 4, and 5-minute periods.

Examination of the samples was made immediately after blanching by three observers in the same manner as described in the experiments to remove the roughness of the skin. The results of these tests are given in Table 4.

After the samples had been examined they were placed in No. 1 tall cans and covered with hot water. The cans were given a 4-minute exhaust, sealed, and sterilized 10 minutes.

From the data in Table 4 it may be seen that dipping the hard-ripe figs in a boiling 2 per cent sodium bicarbonate solution for 25 seconds and

Table 4. Effect of combination of bicarbonate dip and boiling-water blanch on texture

Maturity	Type of dip	Length of dip (seconds)	Length of blanch (minutes)	Observation on texture
Hard ripe	2% sodium bicarbonate	25	1	poor
Hard ripe	2% sodium bicarbonate	25	2	poor
Hard ripe	2% sodium bicarbonate	25	3	good
Hard ripe	2% sodium bicarbonate	25	4	excellent
Hard ripe	2% sodium bicarbonate	25	5	fair
Ripe	2% sodium bicarbonate	15	1	poor
Ripe	2% sodium bicarbonate	15	2	poor
Ripe	2% sodium bicarbonate	15	3	good
Ripe	2% sodium bicarbonate	15	4	excellent
Ripe	2% sodium bicarbonate	15	5	good

the ripe figs for 15 seconds, both dips being followed with a 4-minute blanch in boiling water, gave both lots of figs an excellent texture. Since the canning process would probably soften the figs somewhat, it seemed likely that a 3-minute blanch might be more desirable. This was amply verified by the examination of the canned samples one month later and by subsequent canning tests.

Effect of Maturity

To determine the effect of maturity on the quality of the canned figs, hard-ripe and ripe fruit were canned, using the combination dip and blanch as described above. The figs were placed in No. 1 tall cans and covered with a 50° Brix (27.3 Baume′) cane-sugar sirup. The cans were

then exhausted in steam until the contents reached a temperature of 160° F., after which they were sealed and cooked at boiling-water temperature for one hour. After several weeks and again after six months some of the cans were opened and the contents examined. The first observation was made by two and the second by nine individuals. The ripe figs and their sirup were found to have a richer amber appearance than the hard-ripe figs, of which both the fruit and the sirup had a greenish cast. The ripe fruit also had a much more pronounced fig flavor.

Exhausting

At various times during the experimental canning, observations were made to determine the length of exhaust in steam at atmospheric pressure (212° F.) needed to have the temperature of the fruit at 160° F. when the cans are sealed. When the figs were canned immediately after blanching and covered with sirup which had been heated to boiling, no exhaust was necessary. When the figs were canned in No. 1 tall cans immediately after blanching and filled with cold sirup, about a four-minute steam exhaust was required. When the figs were allowed to cool after blanching and then canned and covered with a cold sirup, about an eight-minute steam exhaust was needed for No. 1 tall cans.

Cooking

Ripe figs were canned in No. 1 tall cans; the best of the above-found methods were used after the cans had been sealed they were cooked at boiling-water temperature for 30, 60, 90, and 120 minutes. Later examination of these samples showed that the 60-minute cook was the most desirable. The 30-minute cook left a slight green taste in the figs and the longer cooks gave no improvement over the 60-minute cook. Probably the length of cook needed will vary somewhat from year to year with the quality of the figs.

Cooling

Ten minutes in running water at about 80° F. was found to be a sufficient time to cool the contents of No. 1 tall cans to prevent after-cooking, and to allow the cans to dry without rusting.

Consumer's Reaction

To test the consumer's reaction to the product several cases of figs in No. 1 tall cans were packed, using the best methods in the above experiments. Cans were distributed to a representative lot of 50 people, who were asked to give their opinion of the product. As a further check on the method of canning, individuals were questioned closely on the points which had been under study in the experimental work. Those who were pleased with the product were recorded as positive and those who were either indifferent or did not like the product were recorded as negative. The result of this test was 47 positive and 3 negative.

Recommended Procedure for Canning Figs in Light Sirup

To simplify the conclusions which were drawn from the above experiments the following summary of the procedure found to be best for canning Magnolia figs in light sirup is given:

1. Select sound whole fruit slightly beyond the hard-ripe stage.
2. Remove stems.
3. Dip figs 15 to 30 seconds, the length of time depending upon the ripeness, in a boiling 2 per cent sodium bicarbonate (baking soda) solution.
4. Blanch dipped figs in boiling water 3 minutes.
5. Allow figs to drain for a few minutes and place in No. 1 tall tin cans.
6. Cover figs with a 50° Brix (27.3° Baume′) sirup containing 0.35 per cent of citric acid (based on the weight of the sugar).
7. Exhaust until contents of cans reach 160° F.
8. Seal cans and cook at boiling-water temperature for 60 minutes.
9. Cool cans in running water for 10 minutes.

CANDIED FIGS

Candied figs have been made commercially from Magnolia figs that had been preserved in cane-sugar sirup of about 28° Baume′ density. The sirup was drained from the figs, which were placed on screen trays and dried in a dryer until no longer sticky.

The finished product was of good quality but the sugar had a tendency to crystalize on the outside of the fig in a short time. An objection to the method used was that since the sirup concentration was not built up to a very great degree in the figs, a very long drying period was necessary to finish them.

Addition of Glucose

The addition of glucose is a common method of preventing crystalization in candied fruits. Cruess (3) recommends the use of one part of glucose and two parts of cane sugar by weight in making up the sirup for candying fruits.

Tests were made to determine the effect of various proportions of cane sugar and glucose on the appearance, texture, and flavor of candied Magnolia figs made by the method outlined above. The figs used in the tests were of fair quality. The glucose used in the tests was in the form of a granulated sugar. Observations were made by numerous individuals,, including some who were connected with the preserving plants. Judging was done by observing and eating some of the candied fruit from each sample so that comparative results could be obtained. A final single observation on the samples was made about two months after the fruit had been candied. The results as given in Table 5 represent the opinions of the majority of those who examined the samples.

This table shows that forty per cent or more of glucose improved the appearance but where more than forty per cent of glucose was used both the texture and flavor were poorer. The effect of too much glucose

Table 5. Effect of glucose on candied Magnolia figs

Per cent cane sugar in sirup	Per cent glucose in sirup	Appearance	Texture	Flavor
100	0	poor	good	fair
80	20	fair	good	fair
60	40	good	good	fair
40	60	good	fair	poor
20	80	good	fair	poor
0	100	good	poor	poor

was to produce a tougher and more gum-like texture, and to give a less sweet and less pronounced fig flavor. With no glucose or only 20 per cent of glucose the candied fruit soon became covered with a hard crystalline coating of sugar.

Modified Methods

Several methods were tried out to find suitable ways for making candied Magnolia figs of good quality as cheaply as possible. It was found that lye-peeling could be eliminated if after the removal of stems the figs were dipped for 15 to 30 seconds in the boiling 2 per cent bicarbonate solution, as previously described, to remove the roughness of the skin.

The time of drying at 120° F. could be reduced from 48 hours or longer required by figs that had been candied by the method formerly used to 12 hours or less when the sirup concentration was built up to about 70 per cent before drying. Two of the candying methods used that gave good results are as follows:

(1) In the case of the riper figs the stems were first removed and the figs dipped in a boiling 2 per cent sodium bicarbonate solution for 25 seconds. After being rinsed in fresh water they were placed in the kettle and covered with a 30° Brix sirup made up with sixty per cent of cane sugar and forty per cent of glucose. The contents of the kettle were brought to a gentle boil and allowed to simmer a few minutes. The figs were left standing in the sirup over night and the next day the concentration of the sirup was increased to 40° Brix by the addition of sugar in the ratio of sixty per cent of cane sugar and forty per cent of glucose. The figs were again brought to a boil and again allowed to stand over night. This process was repeated each day, the concentration of the sirup being increased 10° Brix until it reached 70° Brix.

The figs were allowed to stand in the final sirup for a minimum of 48 hours, after which they were removed and allowed to drain. They were then dipped in warm water to remove the sirup from the surface and put on screen trays, which were placed in the dryer at 120° F. Drying was more even if at the end of about 6 hours the figs were turned over on the trays.

(2) Figs which were at the hard-ripe stage of maturity could be candied in a shorter length of time by the following process: They were either lye-peeled or dipped in the boiling 2 per cent sodium bicarbonate solution and then rinsed in water. The prepared figs were added to a 16° Baume′ sirup containing sixty per cent of the sugar as cane sugar and forty per cent as glucose, and boiled until the sirup had reached a concentration of 28° Baume′ hot. They were allowed to stand in the sirup overnight and the next day the figs were boiled with the sirup until the concentration was 34° Baume′ hot. After standing in this sirup the figs were removed and allowed to drain, dipped in hot water, and dried at 120° F. as described above.

Use of Acid

It was found with ripe figs that when citric acid was added to the sirup in which the figs were candied in the amount of 0.35 per cent of the weight of the sugar the flavor was improved. The calculated amount of acid was added with each addition of sugar to the sirup.

Use of Pectin Dip

After drying, some of the candied figs were dipped for one minute in a 1 per cent pectin solution, allowed to drain, and redried. The pectin solution was made up with water from a commercial powdered fruit pectin. These samples had a brighter appearance than those which were not coated with pectin.

To determine if the pectin coating had any value in preventing stickiness due to the condensation of water on the surface of candied figs exposed to moist air they were dipped in 1, 2, 3, and 4 per cent pectin solutions for one minute, redried, and left exposed to the air for 6 days. The results as shown in Table 6 indicate that the pectin coating is of material

Table 6. Effect of pectin dip

Per cent pectin solution	Length of dip	Observation after 6 days
0	0	sticky
1	1 minute	slightly sticky
2	1 minute	very slightly sticky
3	1 minute	not sticky
4	1 minute	not sticky

aid in preventing stickiness. The pectin seems to form a tough film around the fruit which prevents the moisture from coming into contact with the sugar. For figs packed in cartons or boxes a one-minute dip in a 1 to 2 per cent pectin solution will probably be sufficient.

PRESERVATION OF MAGNOLIA FIGS IN SULFUROUS ACID

Sulfur dioxide as a gas or in solution with water has many uses in the fruit industry. It is an excellent preservative and has the property of combining with color compounds in the fruit to render them colorless. With most fruits the bleaching effect is temporary; for the original color of the fruit is gradually restored, owing to the loss of the sulfur dioxide through oxidation and volatilization. This property is utilized in the dried-fruit industry to preserve the color of light-colored dried fruits, which would otherwise become very dark in a short time if no sulfur dioxide were used. Sulfur dioxide is used as a temporary preservative for many fruits and fruit juices. More recently it has been used to prevent the darkening of apples which have been peeled and sliced for the bakers' trade (5). Recent tests in California (6) have indicated that peaches may be temporarily preserved in sulfurous acid.

Tests were made with Magnolia figs to determine if they could be preserved in sulfurous acid and what concentrations were necessary to hold the figs. A means of removing the acid so that the fruit could be made into finished products was also found.

Effect of Concentration of Sulfurous Acid on Time of Keeping

Magnolia figs at the hard-ripe stage of maturity were washed and placed in quart glass jars. A sulfurous acid solution was made by bubbling sulfur dioxide gas from a cylinder through water. This solution was diluted with water into solutions with concentrations of approximately 1000, 2000, 3000, 4000, and 5000 parts per million, as determined by iodometric titration. Several lots of figs were covered with these solutions and the jars sealed and held for observation.

At various intervals the figs were examined for appearance and texture. The results of these examinations over a period of one year, as given in Table 7, show that the figs in the solution of 1000 parts per million

Table 7. Effective Concentration of Sulfurous Acid on Keeping Quality

Ppm SO_2 original solution	After 3 months		After 6 months		After 9 months		After 12 months	
	Appearance	Texture	Appearance	Texture	Appearance	Texture	Appearance	Texture
1000	good	good	good	good	spoiled	.....	.....	.....
2000	good	good	good	good	good	fair	fair	fair
3000	good	good	good	good	good	fair	good	fair
4000	good	good	excellent	good	good	good	good	good
5000	excellent	good	excellent	good	excellent	good	good	good

kept in good condition for about 9 months while those covered with the higher concentrations kept for over a year.

Methods of Removal of Sulfur Dioxide

Means for removing the sulfur dioxide from the figs that had been stored in a solution of 5000 parts per million were studied by trying various processes of leaching with water. The amount of sulfur dioxide remaining in the figs was determined by the volumetric iodine method (7).

The figs that had 956 parts per million before treatment were reduced to 139 parts per million of sulfur dioxide by boiling in water for 2 hours. The water level over the figs was kept constant by frequent additions of fresh water. By covering the figs with water, heating to boiling, and draining off the water six successive times, the sulfur dioxide content was reduced to 307 parts per million. The effects of these leaching treatments are given in Table 8. Figs that had been placed in a solution containing

Table 8. Effect of leaching with water on sulfur dioxide content

Treatment	Ppm SO_2 after treatment
None	956
Boiled with water 30 minutes	248
Boiled with water 60 minutes	234
Boiled with water 90 minutes	201
Boiled with water 120 minutes	139
Covered with water, brought to boil, and water drained; 2 times	648
Covered with water, brought to boil, and water drained; 3 times	394
Covered with water, brought to boil, and water drained; 4 times	360
Covered with water, brought to boil, and water drained; 5 times	338
Covered with water, brought to boil, and water drained; 6 times	307

956 parts per million of sulfur dioxide and that had been leached in six changes of water heated to boiling and then made into heavy sirup preserves, had only 34 parts per million at the end of the preserving process. This amount could not be detected by tasting the product.

Since the removal of the sulfur dioxide is accomplished by dissolving it out of the fruit with water, it is probable that many of the soluble solids of the fruit are lost during the process. For this reason products made from figs preserved in this manner would not be comparable to the same products made from fresh figs.

According to the Food and Drug Administration at Washington, D. C. investigations have failed to show that sulfur dioxide is likely to injure the health if not used in excess. Its use has, therefore, been permitted but the presence of sulfur dioxide in a food product which is shipped in interstate commerce must be plainly and conspiciously declared on the label. The Food and Drug Administration further states that some State laws contain specific injunctions against the use of preservatives.

As the sulfur dioxide was removed the figs had a tendency to become hard and leathery. This can be prevented by adding 0.5 per cent of

hydrochloric acid to the water that is used for leaching, following with a short fresh-water treatment to remove this acid. The use of the hydrochloric acid in dilute form is not objected to by the Food and Drug Administration so long as it is pure and is completely removed from the fruit.

Products from Figs Stored in Sulfurous Acid

Preserves made from figs which had been stored in sulfurous acid solution and leached in water to remove most of the sulfur dioxide were fair in appearance and texture but lacking in flavor. For this reason it is believed that the addition of artificial flavoring and perhaps coloring may be desirable in products made from these figs. A few tests were made in which mint flavor and one of the permissible green coal-tar food dyes (1) were added to figs from which the sulfur dioxide had been removed by treatment with water; these figs were then made into preserves. These tests indicated that the figs would absorb the flavor and dye very readily. To conform with the Food and Drug Laws products made in this way should be plainly labeled to indicate the presence of sulfur dioxide as well as the fact that they contain artificial coloring and flavoring.

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SUMMARY

1. The use of 2 per cent lye solutions for peeling figs was found to be satisfactory while the use of a stronger solution is inadvisable.

2. Dipping figs in an acid solution after the lye-peeling process slightly improves the appearance and flavor of the finished preserves.

3. Preserves of good flavor and texture were made from figs which had been given a preliminary dip in a boiling 2 per cent sodium bicarbonate solution to remove the roughness of the skin.

4. A new process for canned Magnolia figs in light sirup is given.

5. Methods for candying Magnolia figs in which the cost of production is lowered and the quality of the product improved are described.

6. Sulfurous acid has been found to be a good temporary preservative for Magnolia figs.

7. Most of the sulfurous acid can be removed by leaching the figs with water.

8. Preserves made from the figs stored in sulfurous acid readily absorbed artificial flavor and coloring.

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