Station Circular 63 July, 1925

Oregon Agricultural College

Experiment Station

# Extraction and Clarification of Pectinous Fruit Juices

By

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and

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CORVALLIS, OREGON

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## EXTRACTION AND CLARIFICATION OF PECTINOUS FRUIT JUICES

To produce a brilliant, clear jelly, it is necessary to have a clear fruit juice.

Cloudiness is due to suspended bodies that cannot be removed by ordinary methods of filtration.

Some substance must be added to a fruit juice that will assist in removing this foreign material.

Because of the resistance brought about by the addition of such a substance, it is necessary to use pressure to force the juice through the filtering medium.

For storage, pectinous juices are best reduced in a vacuum pan and stored in sterilized, sealed containers.

# Extraction and Clarification of Pectinous Fruit Juices

By

JAMES C. BELL and ERNEST H. WIEGAND

This circular covers the results of twenty clarification tests made on various kinds of pectinous juices. Many of these tests were conducted on materials submitted by firms throughout the Northwest. The results are combined in a workable procedure for the clarification of products of this nature.

## PECTIN IN FRUIT JUICES

Pectin is the constituent of a fruit juice that causes it to form a jelly when it is combined with the proper proportion of acid and sugar and the mixture is concentrated to the desired consistency. Not all fruit juices, however, contain pectin in a sufficient amount to produce a jelly having a good body; some, in fact, are entirely devoid of pectin. The best fruits for jelly making, containing pectin in sufficient amounts, are: sour apples, crab-apples, currants, grapes, red raspberries, loganberries, gooseberries, quince, cranberries, and sour plums.

Most fruits are high in pectin when fully mature, and in some instances while still immature. All fruits become low in pectin when overmature. Just when a fruit begins to ripen and when it has lost its green astringent or puckery character, pectin is present, but in an insoluble form. The acid content of the fruit at this time is high.

About the time that most fruits are harvested for the commercial market, they contain their maximum pectin, but may be low in acid. At this time, also, they will have developed their highest quality or flavor. As the ripening process progresses, both pectin and acid undergo chemical changes, the pectin changes to a soluble form and the acid to fruit sugar. When the fruit has become over-ripe, it is usually low in acid and pectin.

## PREPARATION FOR EXTRACTION

The raw pressed juice of many fruits rich in pectin contains only a small percentage of pectin, in some instances practically none. The pectin, being held in the cellular structure of the fruit, remains in the pomace and is not contained in the juice. As the pectin is soluble only upon being heated, it is necessary that all fruits be given a partial cook, the extent of which will depend upon the nature of the fruit.

Very juicy fruits, such as berries, require the addition of only a small amount of water, enough to start them cooking and prevent scorching or burning. Berry fruits should not be cooked longer than to heat them through thoroughly and reduce them to a pulpy consistency. They should be heated merely to a boil, as prolonged heating will destroy some of the delicate flavors as well as the pectin and cause cloudiness in the fruit which makes it more difficult to clarify.

Fruits high in cellular material, such as apples and quince, should have water added to them equal to 50 percent of their weight. It is fur-

ther advisable to cut these fruits into small pieces. Kraut cutters and apple graters can be used for this purpose. Kraut cutters give the best results as the fruit is not reduced to a pulp. The apple grater tears the cells of the fruit, causing cloudiness in the juice after extraction.

**Importance of parboiling.** For high-quality jelly too much care cannot be exercised in parboiling the fruit from which the juice is to be extracted. It is a well-known fact that heating to too high a temperature and too prolonged destroys the effectiveness of the pectin. The method of parboiling has much to do with the clarity of the resulting juice. Long continued boiling, especially if vigorous, destroys the starch cells, releasing the starch into the juice, and thus producing a milky product which is more difficult to clarify.

Work done by the Horticultural Products department indicated that parboiling should be done at temperatures not in excess of 212° F. Parboiling is done in double-jacketed kettles or tanks provided with steam coils.

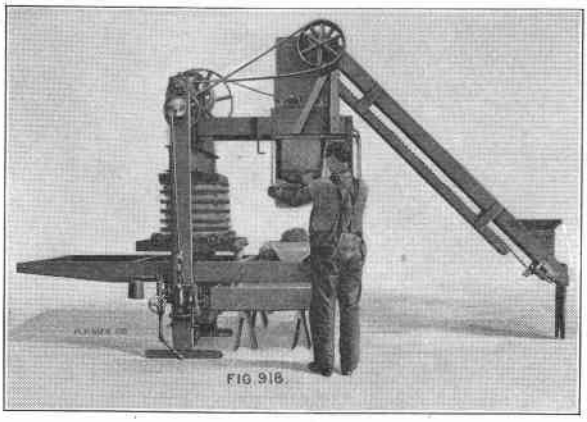


Fig. 1. Hydraulic press.
*Courtesy Hydraulic Press Mfg. Co.*

In parboiling, the fruit should be brought to a slow boil or simmer. That it may heat through as rapidly as possible, it should be stirred occasionally, but not so hard as to break up the fruit into a soft pulp. As soon as it has become cooked through it should be removed from the heat.

## EXTRACTION OF FRUIT JUICE FROM THE PULP

To secure the greatest amount of the pectin contained in the pulp, it is essential that all the juice possible be extracted in pressing. It will be found that the juice which flows off freely will be much lower in pectin than that which has been forced out of the pulp by pressure. For this reason a heavy screw or hydraulic press (Fig. 1) should be used. In applying pressure it should be done slowly as the pectin, being viscous, will flow slowly. Time should be allowed for the juice to flow from the

pulp. Best results are obtained by applying the pressure intermittently, that is, apply pressure and hold while the juice flows off, and then apply more pressure and hold again, and thus continue until all the juice has been pressed from the pulp. It is advisable to have pressing take place as soon as possible while the pulp is still hot.

Since it is our object to remove all the pectin possible from any fruit with which we may be working, anything that will facilitate this is to be recommended. Campbell[1] has found that the addition of a fruit acid (citric) greatly increases the pectin content of the juice extracted. He says:

A factory run on pomace cooked one-half hour with acid, using 4 pounds per 250 pounds dry pomace and a regular run with no acid gave the following results:

| | Regular cook | Cooked with acid |
|---|---|---|
| Sp. Gr. | 1.019 | 1.023 |
| Acid | 0.176 | 0.274 |
| Pectin | 1.610 | 2.29 |

While Campbell[1] carried on this specific experiment with pomace, the same principle will apply to any fruit. He recommends an acidity of 0.3 percent as the most desirable acidity for jelly purposes.

Results of work done at this station indicate that the acid should be added directly to the fruit. The acid has the effect of releasing the pectin in the cellular structure of the fruit. Because of its relatively low cost, citric acid is usually used, although Tarr[2] has found that tartaric acid is much more effective in producing a desirable jelly than citric acid.

## TESTING FOR PECTIN

To test for pectin, add at least an equal amount, but better still twice the amount, of 95 percent alcohol to an equal amount of the juice to be tested. The juice should have been first cooled to room temperature and have been mixed well with the alcohol. If pectin is present in the juice, a jelly-like mass will be formed, which may be gathered together in a spoon. This is merely a qualitative test, but in the hands of an experienced jelly-maker the pectin content can be closely determined. It will be found that different fruit juices give different percentages of pectin. A fruit rich in pectin will give a volume equal to the volume of the juice tested, while one low in pectin will give only a small amount and the mass will be less firm and more of a fluid nature.

## CLARIFICATION OF A PECTINOUS JUICE

Clarification can be carried out best immediately following the pressing of the juice from the pulp. At this time the pectinous juice will be hot and at the higher temperature will flow more readily through the filtering medium.

The foreign materials in a fruit juice that cause cloudiness may be divided into two classes:

1. Solids, either crystalline or amorphous.

2. Suspended bodies having the same specific gravity as the juice in which they are suspended and varying from minute particles to a colloidal condition.

The first-class, solid bodies, can be removed readily by simple filtration through cloths either by gravity or by a pump. The removal of this material facilitates the removal of the second class of materials.

Our tests have shown that a centrifical clarifier (Fig. 2), used for the clarification of milk is the best mechanical means of removing this solid material. The materials that are removed from the juice by the


Fig. 2. Centrifical milk clarifier.
*Courtesy Sharpless Separator Co.*

centrifuge cause most of the difficulty in clogging the filter cloths in the removal of the suspended bodies of the second class. The use of a centrifuge cannot be too highly recommended in the clarification of pectinous juices.

To remove the suspended particles of the second class, either by means of a closely woven filter cloth or through filter masse, Celite should be added to the juice.

Celite is a porous siliceous mineral product of light weight and high purity. It is insoluble, inert, and does not react chemically with a liquid nor alter its character in any way. Its filtering properties are due to its porocity as it forms a layer or cake on the filtering surface through which the liquid passes, slime and other bodies being retained.

There are three different grades of Celite on the market. In this work with pectinous juices for jelly, three grades were used. "Filter-Cel" is finely divided and gives a brilliantly clear product. But for pectinous juices which are somewhat viscous it is too slow for commercial purposes. "Standard Super-Cel" is claimed by the manufacturers to have a rate of flow two to three times that of "Filter-Cel." "Hyflo-Super-Cel" has six to eight times the flow. As far as it was possible to determine by the tests run, little difference was found between "Standard" and

"Hyflo-Super-Cel" in the rate of flow for pectinous juices, nor was there any difference in the clarity of the product. Both gave a clear juice for jelly making.

There are two methods of adding the Celite: (1) directly to the juice to be filtered; (2) pre-coating the filter cloths. Because of the presence of slime bodies in the juices used for these experiments, satisfactory results were not obtained when the Celite was added directly to the juice. When using this method, the mixture soon clogged the pores formed in the filter cake. Better results were obtained when the filter cloths were pre-coated with Celite.

After the cloths of the press have become pre-coated, it will be necessary to add a small amount of Celite to the juice to be filtered. If this is not done a layer of slime will be formed on the surface with the result that the pores will become clogged and the juice will cease to flow.

After the filter cloths have become coated, they will offer considerable resistance to the flow of the filtrate. It will be necessary then to force the juice through the filtering surface under pressure, either by

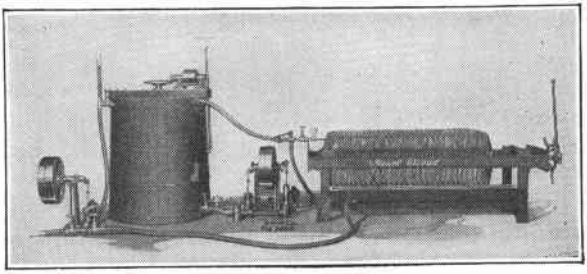

Fig. 3. Horizontal Wood Frame Filter.
*Courtesy Hydraulic Press Mfg. Co.*

means of a filter pump, gravity stand pipe, or draw it through by vacuum with a vacuum pump into a receiving tank.

Because of the cake that is being formed on the surface of the filtering cloths during filtration, the flow of juice will necessarily be slow unless considerable pressure is used. In carrying on this filtration work it was found advisable not to use too great a pressure, but rather to allow the juice to flow more slowly. The greater the pressure used, the more compact will the cake become on the surface of the cloths. A pressure of from five to ten pounds was found to give most satisfactory results. In order to secure capacity it will be necessary to increase the filtering surface.

Pectinous fruit juices have a much greater viscosity than raw fruit juices. The rate of flow of pectinous juices will be considerably below fruit juices for beverage purposes. That capacity may be secured, it will be necessary to use a filter press having a large filtering surface. The horizontal wood frame type (Fig. 3) is best for the purpose. The frame, plates, and other parts with which the juice comes in contact, should be of wood and free from any metal upon which the acid of the fruit juice will react.

The rate of flow will vary from two to three gallons per hour per square foot of filtering surface. Flow may be increased by using a higher pressure, but this is not to be recommended since the filter cake becomes more compacted, which necessitates more frequent cleaning of the filter cloths.

## CONCENTRATING THE PECTINOUS JUICE

Campbell[1] attempted to clarify a pectinous juice with "Filter-Cel" after it had been concentrated in a cider evaporator. He found that, because of its viscosity, the flow was too slow for commercial purposes. In the work done by this Station it was found better first to clarify the juice before concentrating it in a vacuum pan (Fig. 4). The concentration can be accomplished more rapidly by this method at a lower temperature. The pectin, being less affected by the low temperature of the vacuum pan to which it is subjected, will produce a jelly of large volume and of high quality.

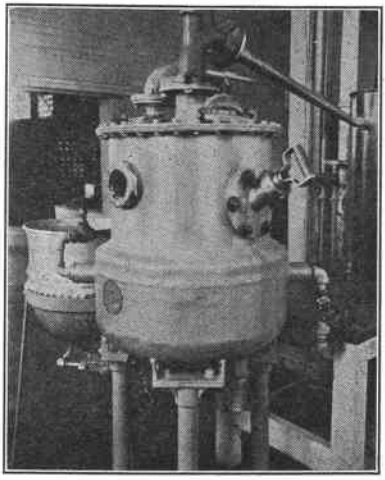

Fig. 4. Vacuum pan used for this work in Horticultural Products Laboratory. *Presented by Pfaudler Co.*

After the juice has been concentrated to the desired consistency it may be run into containers that have been previously sterilized by steam. If the juice is handled quickly without loss of heat, it will not be necessary to give it further sterilization or to add chemical preservatives. If wooden containers are used, however, and the juice is to be held some time before being used, it is advisable to add sodium benzoate to prevent mold growth and fermentation.

When the pectin is to be stored following clarification, without concentration, this may be done by heating it to 180° F. for 20 minutes and transferring it immediately into sterilized cans or bottles and sealing; or if stored in barrels, with the addition of 0.1 of 1 percent sodium benzoate. In either case the juice should be sterilized as soon as possible

after it comes from the press. Should juice be allowed to stand in the open for several hours where it will become highly contaminated, heating to 180° F. will not destroy all the organisms, nor will the addition of the usual amount of sodium benzoate prevent spoilage.

## ACKNOWLEDGMENTS

The authors wish to express their appreciation to the following manufacturers: Hydraulic Press Co., Mount Gilead, Ohio, for cuts of a hydraulic press and a horizontal wood frame filter; Sharpless Separator Co., West Chester, Pa., donation of a centrifical clarifier and a cut; The Pfaudler Co., Rochester, N. Y., donation of a vacuum pan; and The Celite Products Co., San Francisco, California, for the Celite used in the experiments.

## SUMMARY

1. Pectin is the constituent of a fruit juice that causes it to form a jelly when it is combined with the proper proportion of acid and sugar, and the mixture is concentrated to the desired consistency.

2. The best fruits for jelly making containing pectin in sufficient amounts are: crab-apples; sour apples, currants, grapes, red raspberries, loganberries, gooseberries, quince, cranberries, and sour plums.

3. At about the time that most fuits are harvested for the commercial market, they will contain their maximum pectin content.

4. Berry fruits should not be pre-cooked longer than is necessary to heat them through thoroughly and reduce them to a pulpy consistency with only a slight amount of water added.

5. Firm fruits such as apple and quince require water at the rate of 50 percent of their weight.

6. Heat too high and too long continued during parboiling, destroys the effectiveness of the pectin.

7. Parboiling should be done in an open kettle at a temperature not in excess of 212° F.

8. The extract that flows off freely from the pulp will be lower in pectin than that which is forced out of the pulp under pressure. Pectin will flow more freely while the pulp is hot.

9. The addition of a fruit acid to a fruit before parboiling has the effect of releasing the pectin in the cellular tissues of the fruit.

10. When 95 percent alcohol is added to a fruit juice, if pectin is present in the fruit juice a jelly-like mass will be formed that may be gathered together in a spoon.

11. There are two classes of foreign materials in a fruit juice that may cause cloudiness: (a) solids, either crystalline or amorphous; (b) non-rigid suspended bodies having about the same specific gravity as the fruit juice, which may be in the form of minute particles or in a colloidal condition.

12. Solid bodies may be removed by filtering through a filter cloth or other material. A centrifical clarifier also removes these bodies effectively. Effectively removing the solid bodies of the first class facilitates the removal of the suspended bodies of the second class.

13. Celite, an inert, light weight mineral substance, possesses the properties that aid in removing the suspended bodies by forming a porous coat on the filtering surface.

14. To hasten the flow of the juice through the filtering medium, it is necessary to use some force, as a pump, gravity flow stand pipe, or by suction with a vacuum pump.

15. The rate of flow should be two to three gallons per hour per square foot of filtering surface.

16. When a pectinous juice is to be stored without concentrating, it should be heated to 180° F., transferred immediately to sterilized containers and sealed.

17. Because of the viscous condition of a pectinous juice, it should be clarified before being concentrated.

18. Storing in a concentrated form is the best method of handling pectinous fruit juices. A vacuum pan is preferable to a cider evaporator for concentrating the product. The work can be done more quickly and at the lower temperature obtained in the vacuum pan the pectin will be affected by chemical changes.

## LITERATURE CITED

[1]Campbell, C. H. "Some Phases of Commercial Jelly Making." Canning Age. March, 1925.

[2]Tarr, Lester W. "Fruit Jellies. The Role of Acids." Bulletin 134, University of Delaware.