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HOME-MADE CIDER VINEGAR

By WALTER G. SACKETT

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HOME-MADE CIDER VINEGAR

By Walter G. Sackett.

In driving through the fruit-growing sections of the United States, one cannot fail to be impressed with the fact that thousands of bushels of apples and other fruit are allowed to go to waste annually just because it is too much trouble to gather it up and make some use of it. This is particularly true during a season when prices are low owing to an overproduction. Such a practice would be condemned, most certainly, by any commercial firm, and rightfully so, as a most extravagant waste and far removed from any principle of scientific management. Talk with any captain of industry, and he will invariably tell you that the largest profits in his business accrue from the complete utilization of the waste products.

Indifference to the needs of others and ignorance of the latent possibilities in this second grade fruit are largely responsible for the fruit grower's short-sightedness. He is apt to forget that there are a few more than ninety-three million others in this country who are dependent upon him for orchard products such as cider, apple butter, jelly and vinegar, all of which could be made from this fruit which he permits to rot unnoticed under the trees. Could he only be shown the roll of greenbacks or catch the glitter of the gold which would represent his actual net return from the complete utilization of this unnecessary waste, rotten apples, wormy apples, green apples and everything would be cleaned up the next time we should pass by his orchard.

In spite of the fact that thousands of gallons of white wine vinegar, which has never been near a wine press, are produced yearly by a purely chemical process from alcohol, there is still a market for good, old-fashioned, apple cider vinegar. The genuine article will never be entirely replaced by the artificial product. But where is the public to obtain pure apple vinegar of acceptable quality? It is not for sale at the local groceries except in sealed bottles at twenty-five cents a quart. Beside it on the shelf may be found the distilled vinegar, artificially colored with caramel, and the white pickling vinegar at fifteen cents a bottle. In bulk the distilled vinegar can be bought for forty cents the gallon with a reliable guarantee behind it for strength and quality. But you say,

"Surely you must be mistaken about not being able to get cider vinegar from your grocer in bulk." No, gentle reader, do not be deceived by the stencil mark on the end of the barrel. If, perchance, this particular lot came from a nearby ranch, the odds are in favor of its not being worth carrying home. Do not understand me to speak thus lightly of all home-made vinegar for there is some to be found of splendid quality, but it is the exception. As a rule the storekeeper will apologize to the customer for his farm vinegar, but with that which comes from the wholesale dealer it is different. Most certainly a sad condition, when the first and best vinegar that was ever made came from the farm home! What is more, it cannot be obtained from the farmer or apple grower today for most of them are buying all of the vinegar they use.

What has become of our apple vinegar industry, and why have the merchants turned their attention to the distilled article? The answer to this can be had without pursuing an extensive investigation into the economics of the question. It is simply this—the average run of farm vinegar is so inferior to the distilled product that the merchants cannot afford to handle it. The quality is so variable and the strength is so unreliable that the good housewife has learned through the repeated experience of having her pickles spoil not to ask for cider vinegar.

There is no good reason why this condition of affairs should exist which has resulted in placing a boycott on the farm product, but in the light of the facts as they actually exist, is not the consumer justified in taking this stand? There is no doubt that the synthetic article has come to stay, but this does not mean that genuine apple vinegar is a thing of the past. However, until we are able to produce as good or better vinegar on the farm and in the orchard and can guarantee its quality and strength to be reasonably constant, we have no right to ask or to expect the public to buy an inferior product or to help build up the industry by its patronage.

It is just as easy to make high-grade apple vinegar at home when one understands the different operations and principles involved as it is to make good butter or good bread. If the housewife knew as little about making butter and baking bread as the average farmer or orchardist knows about making vinegar, we should all forsake the staff of life and take refuge in the nearest sanitarium.

Selection of the Apples.

What has been said above concerning second grade fruit for cider and vinegar is not to be construed as meaning rotten, wormy, dirty, or unripe fruit. Nothing is gained by such a practice and often all is lost. In the first place, it is impossible to cover up the flavor of the spoiled apples in the vinegar, and in the second place, when decayed and dirty fruit is employed, it is practically out of the question to control the fermentations in the cider upon which the quality of the finished product depends almost entirely.

There is no reason why apples which have merely been bruised should not be used, and where they are not too badly rotted, the soft portion can be cut out. Children are always glad to have a hand in cider making and this is just where their services will fit in nicely. Remember that many hands make light work and likewise clean, acceptable cider, and you will be surprised to see in how short a time the spoiled parts can be removed from the bushels of otherwise worthless apples.

The importance of washing the apples thoroughly with clean water before they go to the mill to be ground cannot be overestimated. There is bound to be a quantity of soil and dust clinging to the outside, particularly where the orchards lie along a public road and are clean cultivated so that the apples fall on plowed ground. This can be carried out very conveniently in an ordinary washtub, after which the apples should be allowed to drain before they are ground. One is always astonished at the amount of mud in the water after such an operation, even when relatively clean, hand-picked fruit is employed.

Let us see next whether all varieties of apples are equally well suited to cider vinegar making; whether a good cider apple is necessarily a good vinegar apple; and what constituent or constituents of the apple determine its usefulness for these different purposes.

In answer to the first question, it may be said that apples differ very widely in their adaptability to cider and vinegar making; some appear to have been created for this very purpose, while others would not do at all.

Concerning the second point, we find it is quite often the case that an apple which makes an excellent cider to drink would not make good vinegar. This is due to the fact that most tastes demand a cider that is not too sweet and with a slight acidity. Such

apple juice would be very apt to make weak vinegar because of the relatively small amount of sugar present.

This reference to sugar brings us to the third item, namely, the important constituents of the apple so far as cider and vinegar are concerned. Several years ago, Dr. Van Slyke of the Geneva, N. Y., Experiment Station, reported a series of analyses of apple juices representing eighty-three different American-grown varieties. He gives the average composition of these juices as follows:

Solids	13.52 per cent
Total sugar as invert sugar	10.91 per cent
Ash	.29 per cent
Fixed acid (malic)	.52 per cent

The sugar is unquestionably the most important of these substances so far as the part which it plays in the making of cider vinegar since the degree of sourness due to the vinegar acid (acetic) is directly proportional to the fermentable sugar present; in other words, all of the acid which was not originally present in the cider as natural apple acid, or malic acid, is produced from the sugar by processes which are soon to be described. Therefore, since from a given amount of sugar just so much acid and no more can be made, we can understand quite readily that for a high grade vinegar of maximum acidity the apple juice containing the most sugar will be the most desirable. The amount of natural acid present in the juice plays an insignificant part in the final acidity of the vinegar, since the small quantity that is present in the apple juice practically all disappears during the change into vinegar. From this it is clear that it is the sugar and not the natural apple acid that is to be considered in cider for vinegar.

Now, as has been stated above, cider for table use is usually more pleasant to drink when it is not too heavy and when the sugar is lower and the acid somewhat higher than the standard for vinegar cider requires.

The composition of the juice of some of our common commercial varieties, especially the sugar content, may be of interest at this time in connection with what has been said with reference to the suitability of different ciders for vinegar making. The

analyses which I am submitting are those given by Dr. Van Slyke* for eastern apples.

Table I—Analyses of Apple Juice of Different Varieties of American Apples.

Variety of Apple.	Specific Gravity.	Solids.	Equivalent of total sugar in form of invert sugar.	Fixed acid as malic.
		Per cent.	Per cent.	Per cent.
Baldwin	1.072	16.82	15.39	.67
Belleflower	1,061	14.09	12.82	.58
Ben Davis	1.052	12.77	10.60	.46
Ben Davis	1.046	10.69	6.74	.44
Gano	1.046	10.16	8.61	.41
Gano	1.056	13.92	11.32	.41
Grimes Golden	1.070	18.18	14.05	.74
Jonathan	1.056	14.62	11.60	.32
Maiden Blush	1.051	12.70	9.99	.67
Northern Spy	1.052	13.77	9.77	.69
Red Siberian Crab	1.070	17.34	11.83	.97
Rome Beauty	1.048	11.37	8.70	.37
Wealthy	1.057	15.26	11.64	.66
Whitney	1.060	14.16	11.39	.40
Winesap	1.065	16.45	13.34	.58
Yellow Transparent	1.049	11.71	9.76	.87

An examination of the above table shows us that there is a wide variation in the percentage of sugar in the apple juice of different varieties, varying from 6.74 per cent. in one sample of Ben Davis to 15.39 per cent. in the Baldwin; that the quantity of sugar in any given variety may vary as much as 4 per cent. (Ben Davis 6.74-10.60).

The amount of sugar depends upon a number of factors such as soil, climate, culture, variety, and ripeness, unripe and over-ripe apples containing less sugar than ripe ones.

†Browne has shown very clearly the changes that take place in the sugar content of apples at different periods of ripeness:

Table II—Sugar in Baldwin Apple at Different Periods.

Date	Condition.	Equivalent of Total Sugar in Form of Invert Sugar.
Aug. 7, 1899	Very green	8.11
Sept. 13, 1899	Green	10.72
Nov. 15, 1899	Ripe	14.87
Dec. 15, 1899	Over-ripe	14.85

The question is sometimes asked whether the so-called "sweet apples" will make as good vinegar as the tarter varieties. All things being equal, there is no reason why they should not, provided they contain as much sugar as the more acid kinds. This statement may seem somewhat paradoxical, but it should be remembered that

*Van Slyke, L. L., Bulletin 258, Geneva, N. Y., Exp. Sta. "A Study of the Chemistry of Home-Made Cider Vinegar," 1904.

† Browne. Annual Rept. Penn. Dept. Agr. 1899, p. 541.

it is the presence of acid rather than the absence of sugar that makes an apple taste sour. As a matter of fact, some of our very sourest sorts contain as much and more sugar than the sweetest sweet apples. Cider for vinegar should not contain less than 8.5 per cent. of sugar.

Storage of the Cider.

The most satisfactory containers for both cider and vinegar are whisky and brandy barrels. Molasses barrels and old vinegar barrels should be used only when no others are available, and then not until they have been very carefully and thoroughly cleaned. Too much stress cannot be laid upon the necessity of scalding old vinegar barrels with either live steam or boiling water to remove the last trace of the old vinegar. There is, perhaps, no one factor which is responsible for more failures in farm vinegar making than the time-honored but pernicious custom of using old vinegar barrels for sweet cider without even rinsing out the dregs of former years. Mere rinsing is not sufficient. They must be scalded to make them fit for use. If this is not done in such a manner as to kill all of the organisms in the barrel, the probability is that the sweet cider which is put in them subsequently will never make vinegar. The reason for this will be given a little later. In a recent number of a certain farm journal, the following is given under directions for making apple vinegar:

"Get a barrel in which good vinegar has been made and use it, or get some of the scum off of the top of good vinegar and rinse out the new barrels with this as soon as they cool after having been thoroughly washed out with boiling water. Put fresh cider into these barrels."

No procedure more absurd and dangerous to the success of apple vinegar could possibly be undertaken than is contained in this recommendation. In fact, it would be difficult to find a better recipe for vinegar failures than this. Never, under any consideration, put either "mother" or old vinegar into sweet cider. It is never safe to use metallic containers for holding cider even for an interval of a few hours, since the acid of the juice attacks the metal, dissolving a portion of it. Such cider, because of the metal in solution, might produce metallic poisoning in the person drinking it.

The sweet cider as it comes from the press may either be placed at once in barrels, which should not be filled more than two-thirds to three-fourths full, or if one has suitable wooden tubs or vats in a clean, cool place, it may be stored there for twelve to

twenty-four hours to permit settling, after which it should be transferred to barrels. The bung should be left out and a loose stopper of cotton batting inserted in the hole to decrease evaporation and prevent dirt from falling in. The barrels should not be tightly stoppered until the vinegar contains at least 4.5 to 5.0 per cent. of acetic acid, at which time they should be filled entirely full and securely bunged. Throughout the entire period of vinegar making, the casks should be placed on their side and not on the end. This gives the cider a larger free surface exposed to the air, which is quite essential to rapid vinegar formation. It may be of some advantage in admitting air to bore a one and one-half inch hole in each end of the barrel along the upper edge. If this is done, the holes should be covered with fine wire gauze or two thicknesses of cheese cloth to exclude small vinegar flies.

The Alcoholic Fermentation.

A few days after the cider is put into the barrels, the characteristic frothing appears at the bung-hole. To use a common expression, "It is beginning to work." This indicates that the alcoholic fermentation, the first step in the vinegar making process, has begun, and the sugar of the apple juice is being converted into alcohol and carbon dioxide gas.

The first of these substances is too well known to need any further comment other than to state that it is this element of "hard" cider that gives it its intoxicating property. With carbon dioxide, many of us are not as well acquainted. It is this gas escaping from the fermenting cider that causes the frothing and likewise the foamy appearance of the bread sponge. It is this gas dissolved in the cider or in the carbonated drinks at the soda-water fountains that imparts to them the characteristic bite or tingle, and upon escaping from the stomach produces that peculiar sensation in the head and nose. Strangely enough, this same gas is the active principle of practically all chemical fire extinguishers.

Now, what is the exciting agent which starts up the fermentation in the bread sponge and in the sweet cider? In both cases it is the same: a microscopic organism, the yeast plant. In the one instance we add a yeast cake to the bread mixture; in the other we either trust to the wild yeasts of the air and the skin of the apples or following the more recent, approved method, we add a yeast cake or a pure culture of a yeast selected especially for this purpose.

To depend upon the wild yeasts of the air to accomplish the fermentation is too uncertain since many of them are able to con-

vert only a small part of the sugar into alcohol, while others act so slowly that they are impracticable. Inasmuch as the percentage of acetic acid in the vinegar depends directly upon the amount of alcohol produced, it is very essential to secure as large a yield of alcohol as possible from the sugar present. This means converting all of the sugar into alcohol in the shortest time possible. The most satisfactory way of doing this is to add one cake of compressed yeast, stirred up in a little cooled, boiled water, to each five gallons of sweet cider. In place of this, one quart of liquid wine yeast, propagated from a pure culture, may be used for each thirty gallons of cider.

During the alcoholic fermentation, the cider should be kept at a temperature of 65 to 80 degrees F. Here is where many make the very serious mistake of putting their fresh cider into a cool cellar where the fermentation takes place entirely too slowly. If the cider is made in the fall, the barrels should be left out of doors for a while on the protected, sunny side of a building and kept warm, unless a regular vinegar-cellar, artificially heated, is at hand.

If yeast is added and the proper temperature is maintained, the alcoholic fermentation should be completed in six weeks to three months in place of seven to ten months as in the old-fashioned way. Experiments along this line have shown that when yeast is added and a temperature of 70 degrees F. is held, the cider at the end of one month contained 7.25 per cent. of alcohol as against .11 per cent. when no yeast was used and the temperature was between 45 and 55 degrees F. Cider kept in a cellar at 45 to 55 degrees with no yeast added required seven months to make 6.79 per cent. of alcohol.

Temperature, alone, is an important factor as shown by an experiment wherein cider to which no yeast was added was held for three months at 70 degrees F. and yielded 6.41 per cent. of alcohol.

There is no question but that the time required for completing the alcoholic fermentation can be reduced at least one-half by adding yeast and by maintaining the proper temperatures. By hastening this operation, the loss of alcohol by evaporation is reduced, and the acetic fermentation can be started that much sooner.

Theoretically, 100 parts of sugar should give 51 parts of alcohol and 49 parts of carbon dioxide gas. This figure has been shown by Browne to be a little high. In actual practice, 45-47 parts of alcohol from 100 parts of sugar is a fair average.

But why not add "mother" or vinegar to sweet cider or put

sweet cider into an old vinegar barrel? Here is the reason: We have seen from what has gone before that alcohol is produced from the fermentation of the sugar. We shall soon learn that the acetic acid of the vinegar is formed from this alcohol. Now, in order to obtain the maximum amount of acetic acid, it is necessary to have as much alcohol as possible in the hard cider, and this can be obtained only by the complete conversion of all the sugar into alcohol and carbon dioxide gas. The complete destruction of the sugar can be accomplished only by the uninterrupted action of the yeast, and the presence of "mother" of vinegar by producing acetic acid interferes seriously with this fermentation. The yeast cells are either killed or their useful activity is checked long before all of the sugar has been changed into alcohol. This is the condition of a very large percentage of farm vinegar—just hard cider that will not and never will make vinegar. It means just this:

A small part of the sugar was made into alcohol and this alcohol was at once changed to acetic acid by the "mother" present; this acetic acid killed the yeast so that no more sugar could be changed to alcohol and no more alcohol being found, no more acetic acid could be made by the "mother." We have a weak, worthless something neither vinegar nor hard cider with considerable unfermented sugar still present and incapable of further fermentation because no yeast can develop in the weak acetic acid solution.

The Acetic Acid Fermentation.

The second step in vinegar making is the change of the alcohol of the hard cider into the acetic acid of the finished product. This is accomplished by the acetic acid germ, another microscopic plant still smaller than the yeast. In some peculiar way it is able to bring about a union between the alcohol of the hard cider and the oxygen of the air so that the alcohol is transformed into acetic acid and water.

As soon as the alcoholic fermentation, described in the preceding section, is completed, draw off the clear liquid, being very careful not to disturb the sediment in the barrel. Wash out the barrel thoroughly and replace the hard cider. It is believed that removing this sediment permits the acetic acid to form somewhat more quickly, and furthermore, the sediment may undergo decomposition and impart a disagreeable flavor to the cider. Again, these dregs may harbor living bacteria which either destroy acetic acid or interfere with its formation.

This done, we are now ready to introduce the acetic acid

germs. This may be carried out in a number of different ways, but preferably by means of a pure culture of a desirable organism which has been selected because of its ability to produce strong acetic acid and to impart an agreeable flavor to the vinegar. In place of the pure culture starter, one may add two to four quarts of good cider vinegar containing more or less "mother" for each barrel. The introduction of a desirable organism is left to chance in this case. A serious objection to this latter method is that sometimes one introduces foreign organisms with the "mother" which may prove detrimental to the vinegar. The pure culture starter is free from this objection. On the whole, the indiscriminate use of "mother" alone is to be discouraged, since the popular idea of what constitutes "mother" is apt to be wrong. Pure "mother" is made up exclusively of acetic acid bacteria and is recognized as the thin, white, glistening, gelatinous membrane that forms on the surface of vinegar. It seldom becomes one sixteenth of an inch in thickness and should be translucent or white in color. It is entirely distinct from the thick, tough, dark brown, slipping, leathery masses which form in vinegar and are usually regarded as "mothy of vinegar." Such accumulations contain the acetic acid germ, in all probability, but in an impure state. In addition to this organism there may be present yeast cells and numerous bacteria which are positively harmful to the vinegar. Often these growths undergo decomposition and give the vinegar a flavor of rotten oranges. Again the germs present may cause the partial or complete loss of the acid, particularly if the barrels are not full and tightly stoppered. All things taken into consideration, the use of this sort of "mother" is a rather dangerous procedure.

With the acetic fermentation, as with the alcoholic, the higher temperatures favor the changes. Experimental work shows that hard cider to which no acetic acid bacteria were added other than those that came from the air, and kept at 65 degrees F., when six months old, contained 7.03 per cent. of acetic acid, while that held at 55 degrees F. showed only 3.63 per cent.

The addition of some kind of an acetic acid starter, either as a pure culture of the acetic organism or as good vinegar, hastens the fermentation and reduces appreciably the time required for making marketable vinegar.

For most satisfactory results we would recommend using the pure cultures and holding the vinegar at a temperature of 65 to 75 degrees F. Under these conditions, salable vinegar can be obtained in three to six months in place of two to three years, as is often

the case. Theoretically, 100 parts of alcohol should give about 130 parts of acetic acid, but in actual practice this will probably fall below 120.

When the acetic acid has reached 4.5 to 5 per cent., fill the barrels as full as possible and cork tightly. In this way, contact of the air with the vinegar is cut off and the acetic acid organisms soon cease their activity. If this is not done and the acetic and other bacteria are allowed to develop indefinitely, there is apt to be a reverse reaction resulting in a partial or complete loss of the acetic acid. Such vinegar is, of course, worthless.

Clarification of Vinegar.

For those who desire an extra fancy product of extraordinary brightness, suitable for bottling, it will be necessary to subject the vinegar to a special process of clarification known as fining. According to Bioletti*, the best results are obtained by using isinglass. This is employed at the rate of from one-half to three-fourths of an ounce of isinglass to each one hundred gallons of vinegar.

"The isinglass is cut into small pieces and soaked for twelve to twenty-four hours in a little water containing acetic or tartaric acid equal in weight to the isinglass used. When thoroughly soft it is then rubbed several times through a fine sieve, gradually adding a little more water until a perfectly fluid liquid is obtained. This fluid is then well mixed with a little vinegar and thoroughly stirred into the cask. With some vinegars it is necessary to add a little tannin, from one-half to one-seventh the amount of the isinglass used. This tannin should be added at least twenty-four hours before the finings.

When the finings have settled and the vinegar is perfectly bright it is ready for bottling."

Pure Cultures for Vinegar Making.

Reference has been made above to the use of pure cultures, both yeast and acetic acid bacteria, for vinegar making. For a little more than one year, the Bacteriological Laboratory of the Colorado Experiment Station has been supplying these at fifty cents (50c) per set, post paid, sufficient for one barrel, to those who care to give them a trial. Full printed directions for their use are included. These cultures have been selected because of certain properties which they possess which make them especially suited to the vinegar industry. No guarantee, either expressed or

* Bioletti, Frederic T., Grape Vinegar, Bull. 227, California Exp. Sta., 1912.

implied, goes with the cultures, since it is not the purpose of the Experiment Station to exploit these products, but rather to distribute them at the cost of production for experimental purposes. Inasmuch as one of the cultures is to be added to the sweet cider, the set should be obtained a few days, not longer, before the cider is to be made.

Requests for cultures should be addressed to the Bacteriological Laboratory, Colorado Experiment Station, Fort Collins, Colorado, and should be accompanied by a remittance of fifty cents (50c).

Directions For Using Pure Cultures in Making Vinegar

Preparation of Yeast Culture.

1. For each barrel of sweet cider, sterilize one two-quart Mason jar by washing thoroughly and boiling for five minutes in clean water.
2. Cover the top of the jar with a single layer of clean muslin or cheese cloth just removed from boiling water and secure it in place by a string tied about the neck of the can.
3. Select 6 or 8 medium sized *ripe* apples; pare and quarter or slice them; add one quart of water and boil till soft; strain liquid through clean cloth while hot into Mason jar, first removing the cloth covering from the top.
4. Make up the volume of liquid to approximately one quart with boiling water; add 4 tablespoonfuls of sugar and replace the cloth immediately.
5. When the liquid has cooled thoroughly, partly remove the cloth covering and add the contents of the culture bottle marked "Yeast." Replace the cloth. Just previous to opening the culture bottle, shake thoroughly and immerse the lip and cork only, ten second in boiling water. Do not touch the lip while removing cork.
6. Keep the jar in subdued light at a temperature of 75 degrees F. to 90 degrees F. After two to four days the foaming characteristic of alcoholic fermentation should appear.
7. After four to six days, add the entire contents of the *yeast* jar to the barrel of freshly made *sweet* cider. *The barrel must not be more than two-thirds full;* it should be placed on its side, and the bung-hole be left open, or, better, plugged loosely with a tuft of clean cotton batting.
8. Keep the barrel at 75 degrees F. to 85 degrees F.

Preparation of Acetic Culture.

1. Three to four weeks after the yeast culture has been added to the cider prepare the Acetic Culture in precisely the same manner as described for the yeast in paragraphs 1 to 6 above. See that all of the culture is removed from the bottle; rinse with a little cooled boiled water if necessary. Do not shake the jar while the culture is developing.
2. By the end of one to two weeks, a white, gelatinous film or membrane should be visible on the surface of the liquid. This is a growth of acetic acid bacteria and constitutes the "Mother of Vinegar."
3. When this acetic membrane is well formed, which will require about two weeks, with a clean sliver of wood, previously dipped into boiling water, remove the membrane from the jar, but do not lay it down; pour the contents of the jar into the barrel of cider, now fermented, to which the yeast was added some five or six weeks before; next drop the sliver with the attached acetic film into the barrel through the bung-hole. The wood will serve to float the acetic membrane on the surface of the hard cider and thereby hasten its development by keeping it in contact with the air.
4. Keep the barrel at 65 degrees F. to 75 degrees F. till the vinegar has formed.
5. When vinegar of satisfactory quality has been obtained, in three to six months, draw off and store at a cool, even temperature in casks which are kept full and tightly bunged.
6. Both of these cultures can be propagated indefinitely by employing a small portion of the jar cultures in the same manner as the original bottle starters.