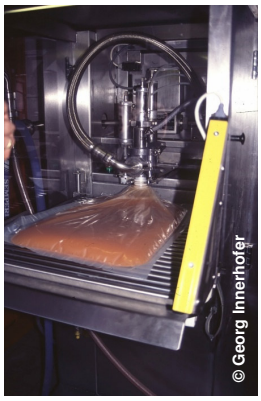
Fruit juice – Knowledge base

Direct (not-from-concentrate) juice or fruit juice concentrate?

There are two main types of fruit juice. On the one hand there is a so-called "direct or not-from concentrate (NFC) juice" and on the other hand the one produced from the "juice concentrate". Both have 100% non-diluted fruit content.

The term "direct or NFC juice" or "made from fruit concentrate" on the label explains how the juice was produced. The juice is either contained in cloudy or clear bottles after juicing or stored for later filling in sterile tanks. This is the usual on-farm method.



In order to get a fruit juice concentrate, the freshly squeezed juice will be dehydrated under vacuum conditions, until the juice is reduced to about one-sixth of its volume. After reconstitution with clean drinking water there will be a fruit juice with 100 percent fruit content again. The use of concentrate must be noted on the product label. The processing of concentrate has no relevance in on-farm fruit juice production.

For an industrial juice producer it has several advantages, which are crucial due to the low consumer prices of redilluted juice. The manufacturers can achieve higher storage capacities, and they can spread the filling evenly over a longer period and thus compensate for years with poor fruit harvest through storage reserves.

Fruit Juice Production - Expertise

Requirements and preconditions

There are certain minimum requirements for equipment and receptacles in fruit processing. Over the past few years, fruit processing equipment has changed considerably. Factors, such as industrial safety or process measuring and control technologies, were accompanied by massive utilisation of new materials; virtually all areas of engineering and machine construction are nowadays dominated by stainless steels and synthetic materials.

Grinding and Crushing Equipment

The first Step, after having selected and cleaned fruits, most commonly is mechanical crushing, regardless of the following steps, which may be squeezing, straining, sieving, cooking etc. For this procedure, numerous devices are readily available. Depending on the production steps to follow, as well as type of machine and adjustment, fruit will be shred or broken up to different degrees. Rather than making the next step the finest, the best possible degree of comminution should be found.

In order to allow juices to discharge, fruit are ground before further processing. All implements, too large in size, reduce the average juice extraction. On the other hand, all mash, too fine will be a serious obstacle in separating solids from liquids. Juices will contain quantities of turbid materials and thus be hard to clarify and decant. The squeezing cloth, used as a filter in this process, will become clogged, leading to increasingly insufficient juice outflow. Those juices contain turbid, a serious obstacle to the final clearing. In mash fermentation, those fine mashes are not considered a disadvantage.

Shredding equipment can be built to different standards, but is normally found as a fixed unit of shredder/mill and squeezer, liberating the operator from having to shift mashes to the squeezing unit.

Pivoting centrifugal mills (grating mills)

Those operate, following a principle similar to that of centrifugal grinders. There core competence is foremost found in the comminution of all pomaceous fruit. Inside, fruit are pressed to the outer edges, utilising a rotor-shaped armature, where they are ripped apart by serrated cutting teeth. Those cutting teeth are interchangeable in accordance to the desired reduction ratio. This kind of shredder is inappropriate for processing stone fruit, drupes or soft fruit.

Straining and Juicing Equipment

Purpose and target of juicing and straining is the separation of liquids from solids. Short juice distances, low pressing force and avoidance of oxidation-related brown-stains an changes of aroma by means of swift processing are crucial factors for the final juice quality.

Nowadays, there are myriads of different straining systems. Most of them originally developed for winery; those capable of fruit processing have been adapted accordingly.

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Hydropresses

Hydropresses have capacities of up to 200 litres and thus aim at rather small juice productions. They are excellent for speciality and custom productions, impossible to manufacture with other types of strainers and juicers. Their production quality is excellent, owed to gentle processing.

A typical hydropress is built on a metal stand, with a vertically mounted cylinder, cylindrical hose or bellow on top. The gap between bellow and outer wall of the cylinder is filled with mash and subsequently closed with a lid. During the squeezing process, water pressure widens the bellow, widening it beyond its outer limits, pressing the mash towards a perforated wall, leading the juice flow. To prevent this sieve from getting clogged, it may be covered with a pressing cloth.

Naturally cloudy, unfiltered Juices

For the production of clear juices, filtration of all turbid is inevitable, whereas in naturally cloudy juices the preservation and stabilisation of those particles, forming turbid is highly desirable.

In central Europe, mainly apples and grapes are or processed as naturally cloudy juices or blends. Because of their constituents, fruit, other than those, are not as easily processed into naturally cloudy juices.

Freshly squeezed apple juice contains certain agents (foremost pectin) increasing its viscosity on one hand, but on the other hand leading to electrical molecular bonding and thus are responsible for a relative physical stability of the juice, preventing turbid from falling out and settling. Bringing as much of a fruit's pectin as possible into the juice is highly desirable.

Large quantities of pectin form gel, as observed in jams and marmalades. Smaller quantities lead to insignificant thickening. Juice is slightly thicker, turbid doesn't settle as easily. Apart from that, pectin forms a kind of shield around turbid, additionally preventing fallout and settling.

Naturally cloudy, unfiltered apple juice

Fruit selection and the appropriate technology determine turbid intensity and its stability.

- *Unripe apples* have exceptionally high pectin contents. During the squeezing process, however, the pectin is held back with the pomace, insolubly bound in long chains and thus does not transfer into the juice. Furthermore, unripe fruit lack aroma and sugar. Pressing unripe fruit harms the overall quality of the juice.

- Whereas *Fully ripened apples* present high contents of soluble pectin which during the pressing process transfers into the juice, increasing viscosity and turbid stabilising.

  Long-chained pectins are partially eliminated, also leading to softer apples. Squeezing transfers higher pectin contents into the juice.

  Fully ripened fruit present high sugar contents and fully developed flavours and thus are best for processing.

- *Overripe apples* are inadequate for the production of naturally cloudy juices. Their relative softness is an obstacle to proper squeezing. Mushy constituents frequently get into the juice and can later be found at the bottom of the bottle. Following the apple's natural ability to withdraw pectin by means of enzyme, overripe apples present low or now pectin contents. Juices drawn from overripe fruit are inappropriate for the production of naturally cloudy juices.

- *Mouldy or rotten fruit* shall not be used. Due to active micro organisms, they contain high quantities of pectin-reducing enzyme, causing oxidation. Their use will negatively affect flavour and turbid stability.

- *Variety Selection* is of equal importance. Pippin- or dessert apples in general present higher turbid contents than cider apples. Many times, cider varieties have high contents of natural tannin agents, leading to flaky oxide dropouts, which settle on the bottle's bottom. Those are inadequate for producing naturally cloudy fruit juices.

Processing

Turbid is formed of cellular modules from the cell's wall and its membrane, also precipitation due to distortion of the fruit's structure. The quantity of cellular elements in the juice depend on the mechanical force during grinding, transport and straining.

Large turbid quantities lead to undesired residues at the bottle's bottom. Gentle processing will increase the likeliness for low turbid contents. Vigorous processing will increase turbid quantities. Juices with a large stability in their turbidity can only be drawn from clean and healthy fruit.

Common procedures

The easiest method is direct pasteurisation, immediately upon discharging juices from the squeezer. Providing gentle pressing of perfectly structured apples, this will work very sufficiently. Should there be higher turbid contents, it is recommendable allow a few hours for those suspended particles to settle. Following this step, the juice will be drawn by means of a drain hose, then heated and bottled. During the resting period there is a slight danger of natural enzyme damaging parts of the pectin content. (Especially true at higher temperatures). Thus there is an increased danger, especially with overripe fruit, that after the pressing undesired clearing takes place. This method can only be recommended for perfectly clean starting material and low juice temperatures. It may make sense, to cool Apples before their squeezing.

More advanced methods, such as flash pasteurisation or employment of a centrifuge are pretty much reserved to bigger businesses.

Oxidation Protection

Species, degree of ripeness, as well as juice temperature have tremendous influence on the likeliness to oxidants causing mash and juice to turn brown. Species and their individual juice composition determine the degree of browning. Overripe fruits brown significantly more than those, fully ripe. The same applies to the juice temperature; the warmer and the longer it rests, the more intense the browning reaction.

To assure a light colouring under all circumstances, ascorbic acid is added immediately upon Pressing. Slight browning will vanish under the influence of 150 mg/l ascorbic acid; the juice will subsequently be protected against undesired browning. Apart from its brightening function, ascorbic acid has positive effects, stabilising turbidity. Higher doses between 200 and 500 mg/l may exceptionally be used to fulfil certain specifications. Under the influence of those higher doses, juices will become very light to almost white.

Turbid Depot

Even under highest technical standards, flaky residues and lump formation at the bottle's bottom can't be completely eliminated.

Under most circumstances those compounds result from bonding of natural tannins and proteins. In most cases they are easily diluted by means of shaking. Insoluble lumps will quickly settle on the bottle's bottom. In some cases, consumers will reject to those juices, but in most cases they know, that turbid doesn't mean a deterioration of quality or flavour.

Being a clear indicator for a natural product, this ultimate remainder of fruit residues can be neglected. In juice production not everything is predictable and foreseeable.

Clear fruit juice

Having selected appropriate fruits, these are cleaned, chopped and strained. There should be the least possible time gaps between those production steps, in order to give micro organism growth and oxidation as little time as possible. Oxidation protection is extremely desirable with juices with a high likeliness to brown, as well as to obtain very light coloured juices.

Treatment agents – Embellishment

In accordance to the fruit, originally used, after the straining process variations in the degree of turbidity will be observed. Even with low turbid juices, filtration at this production stage would be inefficient. Thus in order to reach a cosmetic clearing, the addition of clearing agent is the most common method to start the clearing process.

As seen in detail in the unit on treatment agents, a a clearing will be most successful at a temperature of 12 °C. At lower temperatures, the straining process should only be started if there is an option for heating the juice, best be achieved with a tubular heat exchanger.

Oxidation Protection

In most cases, fruit juices will be of a pleasant light colour, after the clearing process. Overripe fruits, meaning not completely satisfactory raw material, however, as well as time-consuming production procedures, may lead to undesired browning reactions in the juice. The browning intensity varies in accordance to the processed variety, temperature, ph-value, total acidity and also air admittance. Some species are very prone to browning, whereas others aren't.

To prevent juices from browning from the beginning, L-ascorbic acid may be added. This can be done either directly after the pressing or later in the tank. Under normal circumstances, for apple- or pear juice, between 150 and 200 mg/l are added. Treatment with higher doses or treatment of very light juices will lead to almost watery light juices. Most consumers would consider those untypical; thus overdosing or dosing without previous indication should wilfully be neglected.

Enzyme treatment

BTo initiate the clearing process, a pectolytic enzyme is utilised. Addition of pectolytic enzyme accelerates the reduction of the turbidity stabilising pectin shell, the juice's viscosity is reduced and turbid begins to form sediments.

In the tank flocculating should be observer just minutes after the enzyme was added. Any obstacle to enzyme treatment can make the clearing process very difficult, as dissolved pectin raises the viscosity, hindering turbid to settle.

If pectolytic enzyme was added to the mash, this step doesn't necessarily have to be repeated with the juice. To have reliable feedback on the pectin degradation, a pectin test can be utilised. 5 ml of juice and 5 ml of pure alcohol are mixed in a test tube. Should flocculation occur, this is considered a clear indicator for insufficient pectin degradation; before clearing a second batch of enzyme has to be added.

The enzyme's application rate varies in accordance to the individual product and its application. It is normally indicated on the packaging. Overdoses don't deteriorate the flavour but can be an unnecessary expense.

Utilisation of starch breaking enzyme is only indicated for processing unripe apple at the beginning of the season.

Protein Stabilisation

Protein is a natural ingredient of all fruit. It doesn't deteriorate fruit processing. It isn't until pasteurisation that it causes flocculation under heat treatment, causing turbidity, which can be observed as cellular striation. This form of cloudiness does not influence flavour or shelf life, but is considered impairing and undesirable.

Heat sensitive proteins will thus in the process be removed from the juice. There are two common methods of removing proteins.

Cosmetic Bentonite Treatment

Bentonite's effectiveness is significantly determined by means of proper soaking. Increasing the layer distance will enhance negative charges, whereas positively charged proteins will attach themselves to the bentonite.

After soaking in water, bentonite is emulgated with a specific part of the juice and subsequently added to the remainder, approximately two or three hours after the enzyme, best done from above. Ater about 15 minutes, the container has to be stirred once more.

High-Temperature-Short-Time Procedure

High- short heating is of little or no influence for plain, direct juices, with the exception of manufacturers storing the juice in sterile "KZE" containers.

Cosmetic clarification – gelantine clearing

The clarification of fruit juice is dominated by the utilisation of powdered gelatine, which is cheaper to procure, has a longer shelf-life and is more effective. Liquid gelatine solution is easier to use, with a shorter shelf-life and more expensive.

Approximately 30 minutes after the bentonite has been stirred into the juice, the gelatine can be added to the juice. It has to be stirred into the juice in order to achieve a homogeneous tank content. Agitators with bigger wings and slow action will work better than small propellers with rapid rotation. With their slow motion, they are more likely to disaggregate any flocculation.

Silica-gelatine clearing

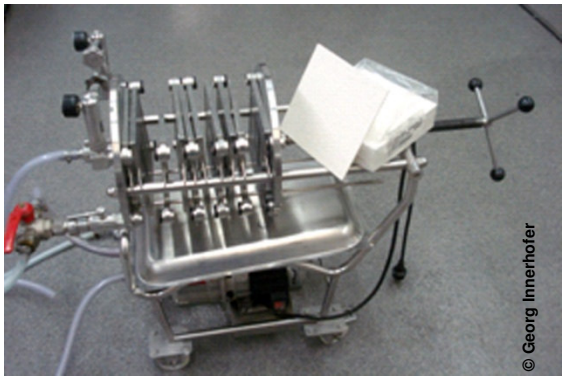
The addition of silica will permit gelatine residues to vanish from the juice, which would later cause sediments to form clouding. Furthermore, silica will increase tarnish compactness.

Estimates for cosmetic clearings

150 g bentonite
15 g gelatine (75 ml dissolution)
75 ml silica (concentration 30 %)

These estimates refer to 100 litres of apple juice from ripe fruit, following adequate enzyme treatment.

Filtration



In most cases, cosmetic treatment on its own is not sufficient, in order to maintain clear or bright juice qualities. Thus, all cosmetic treatment is normally flanked by a filtration process and finally completed by heat treatment and bottling. In general, hot-filling following diatomite filtration will make sterilisation obsolete.

Preservation

In order to preserve fruit juice, in general pasteurisation (hot-filling) is the most common quality-determining method. Apart from the overall temperature, its duration is of tremendous significance.

Total temperature and duration of heat impact determine the effectiveness of the sterilisation process.

Natural cloudy juices, due to their higher enzyme contents and thus higher plate count, should be bottled at a minimum temperature of 80 °C. Pasteurising equipment lacking exact temperature control are prone to failure. Temperatures, exceeding this will harm colour, flavour, as well as important ingredients, e.g. vitamins.

Hot-filling

Hot filling is the best known method for the preservation of non-sparkling (devoid of carbon dioxide) drinks. It is employed at temperatures, lower than 100 °C and therefore is known as one method, known as pasteurization. Bacteria, which later could cause spoilage, are eliminated by means of heat.

Nectar or syrup bottled cold (at room temperature) will transport harmful germs, drawn from the fruit, the equipment or the bottles, which will soon cause fermentation or mould. This will not easily happen with hot-filling.

Hot-filling

- eliminates micro-organisms in the beverage
- eliminates micro-organisms in the bottle
- inactivates the fruit's enzyme

Though sensitive to high temperatures, micro-organisms won't fall off immediately after reaching a certain temperature. The extent of depletion is highly dependent on temperature and duration of heat treatment. The higher the temperature and the longer it is held, the more micro-organisms will be eliminated.

Thus, it is a matter of choice, to heat in the 60 °C region for a period of hours or in the 80 °C region for just a few minutes. The effect on the product's shelf life is the same. But the loss of vitamins, freshness and fruitiness is significantly higher with the long-heat approach.

Heating to 80 °C will also change and inactivate enzyme. Those would lead to a substantial decrease of colour and aroma; produce containing fruit pulp would undergo a quick reduction of turbid. Once processed, turbid is not considered an increase in quality, nor to have positive effects on the nutritional properties of the juice. As opposed to this, the elimination of enzyme is inevitable for an extended shelf-life.

Bottles or lids don't have to be sterilised, heated or treated against germs by any means before filling. A visually dust free cleanliness will do. The heated juice will complete the antibacterial effect.