Coloured fruit processing

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The healing effect of berries has been known to natural medicine since antiquity. Berries and red stone fruit, such as cherries and plums, catch the eye with their red or bluish colours. The colouration is due to the anthocyans which bind with free radicals in the body and so form an important component in a healthy diet.

Coloured fruit also contain vitamins and minerals, as well as anthocyans. The black currant is particularly noteworthy, as it has the highest vitamin C content of any central European fruit. Another feature of berry fruit is the high fruit acid content compared to sugar content. This combination makes coloured fruit juices an important component in blending juices, or even as a basis for jellies, and the reason why they have enjoyed great popularity for decades.

Coloured juices are primarily valued for their appealing colour. This is why all high-quality processing considerations are geared towards releasing and preserving anthocyans. All coloured fruit exhibit individual characteristics where sensitivity to contact with fining agents or stability at high temperatures are concerned. The choice of the right process using suitable clarification and filtration aids presents an exciting challenge.

Mash enzymation

Fructozym® EC Color

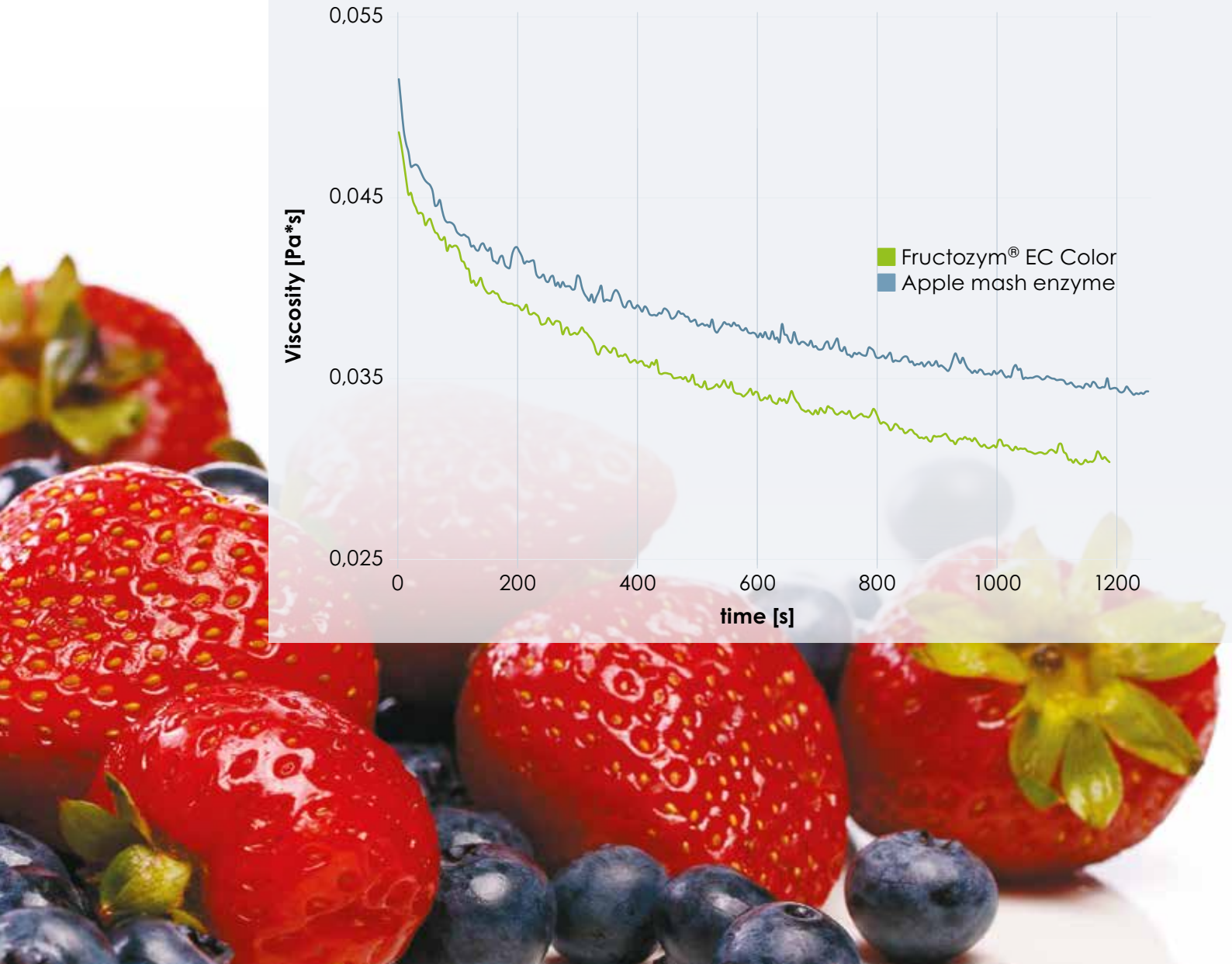
Acid-stable pectinase for coloured fruit processing

A processing temperature bordering on the limits of enzyme stability is usually selected to extract the maximum colour. The lower the pH value, the lower the processing temperature that should be chosen to ensure maximum enzyme activity. It becomes borderline for standard pectinases where black currants with pH values below 3.0 are concerned.

Enzyme preparations for coloured fruit processing, such as **Fructozym® EC Color**, are therefore very acid-tolerant in order to achieve maximum performance at this threshold. This is apparent from the faster reduction of viscosity in the fruit mash and juice.

Other requirements are maximum colour yield and retention during subsequent treatment stages, such as clarification, stabilisation and filtration.

Comparison of Fructozym® EC Color and an apple mash enzyme with the same concentration of pectinase activity



Fructozym® Color

Maximum colour extraction and pectin degradation even at low temperatures

In recent years the trend towards cold juice processing has gained increasing acceptance where production of stable coloured fruit juices is concerned. As a result of the lower temperature, this processing allows adsorption of condensed polyphenols during fining and therefore better stability compared to hot-fined coloured juices (such as clear elderberry juice concentrate). **Fructozym® Color** is an enzyme that bridges the gap between hot mash enzymation at 50-55 °C with maximum colour extraction and complete pectin degradation at 15-25 °C.

Classic production of clear black currant juice

All numbers calculated per ton resp. 1,000 L of juice

- Squeezing
- Tube heater 55 °C
- Mash enzymation Mash tank 2–3 h — **Fructozym® EC Color** 120–200 mL
- Press
- Optional: 2nd pressing after water addition
- Inactivation of oxidases Pasteurisation
- Juice enzymation 55 °C | 1–2 h Degradation of pectin & colloids — **Fructozym® EC Color** 10–30 mL, **Fructozym® FLUX** 15 mL
- Fining
- Filtration

Processing of strawberries into clear strawberry juice concentrate

All numbers calculated per ton resp. 1,000 L of juice

- Squeezing/Warming 25 °C
- Mash enzymation Mash tank 3–4 h | <30 °C — **Fructozym® Color** 80–120 mL
- Press
- Optional: 2nd press after water addition
- Aroma recovery pasteurisation
- Centrifuge
- Juice enzymation 15–25 °C | 3–5 h Degradation of pectin & colloid — **Fructozym® Color** 40–60 mL
- Fining
- Ultrafiltration
- Evaporation

Strawberry processing represents a peculiarity, as strawberries tend to go brown very quickly and as a result the juice's bright colour becomes overlayed with brown pigments. Gentle processing at low temperatures guarantees high-quality juices and concentrates.

Fructozym® BE

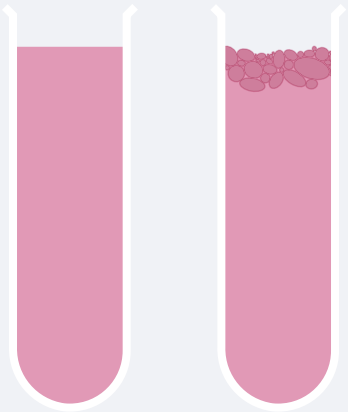
Reliable pectin and glucan degradation in difficult harvesting conditions

Particular attention must be paid to processing of very soft berries that are inclined to form mould. This can be caused by rain, as well as bruises and extended transportation. As it is technically impossible to detect and sort all bad fruit, the glucan formed repeatedly causes pressing and filtration problems during the season.

In this case, a reduced mash and juice temperature, combined with **Fructozym® BE** pectinase, can turn an unpressable mash into a mash that can be pressed normally. This is possible as a result of the auxiliary glucanase activity. The glucan test can be performed in the laboratory using a modified alcohol test.

Glucan test

- Pour 10 mL juice sample in a test tube (in juice containing mix-beverages, accordingly more)
- Add 5 mL ethanol (96 %)
- Mix sample carefully; do not shake!
- Interpretation after 60 minutes (the formation of thick-walled bubbles is an indicator for glucan)



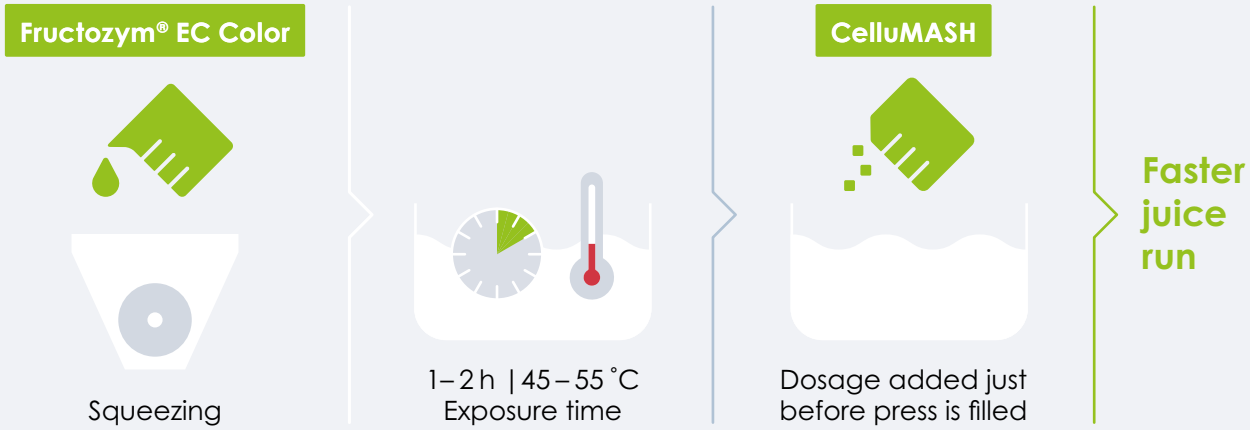
glucan free not glucan free

Processing of blueberries into clear concentrate

All numbers calculated per ton resp. 1,000 L of juice

- Squeezing
- Tube heater 30–40 °C
- **Mash enzymation** Mash tank 3–4 h — **Fructozym® BE** 120–300 mL
- Press
- Optional: centrifuge
- Inactivation of oxidases Aroma recovery pasteurisation
- **Juice enzymation** 50 °C | 1–2 h Degradation of pectin & colloid — **Fructozym® BE** 12–40 mL
- Fining
- Precoat filtration

Procedure when using CelluMASH



CelluMASH

The pressing auxiliary for weak-structured fruit mashes

During the harvest, strawberries and even black currants are often mashed and transported by tanker to a juice producer for further processing. These mashes completely lose their drainage structure as a result of the long contact time and are also very difficult to juice using hydraulic pressing equipment. Even structureless mashes, from purées, overripe strawberries or gooseberries, are very difficult to juice without additional structure.

Long-fibred pressing aid **CelluMASH** is added to the mash immediately before pressing and provides the fruit mash with sufficient structure so that the juice can emerge from the drainage channels thus created, resulting in a dry pomace. This reduces the pressing time and increases the yield, which represents a clear increase in added value when processing valuable fruit. Another positive effect is that the drainage tubes and press belts do not get as clogged with pomace. This drastically reduces the amount of cleaning required, which saves cleaning time and the use of cleaning agents

CelluMASH remains in the pomace, is fully compostable and can be disposed of via the pomace at no cost. Customary dosages are 0.75–3 kg/100 kg mash

Juice treatment

Pectin degradation

After the enzymated fruit mash has been pressed, the juice obtained is pasteurised immediately. On the one hand this serves to deactivate natural oxidases which lead to enzymatic browning reactions, but also to kill yeasts and bacteria that would otherwise spoil the juice. This extends the window during which the juice can become clear juice.

Before the juice can be clarified and stabilised, the pectin which is dissolved in the juice must be completely degraded, after pasteurisation. The pectinase used to break down the mash is used for this. In the case of some fruits, subsequent clarification and filtration benefits from the hemicellulytic side activities of enzyme preparations **Fructozym® Flux** and **Fructozym® Flow UF**.

It is essential that a check for any residual pectin be carried out before fining, as even small quantities can increase viscosity so that the fining agent has great difficulty reacting and clarification is not very successful, or requires very high application rates.

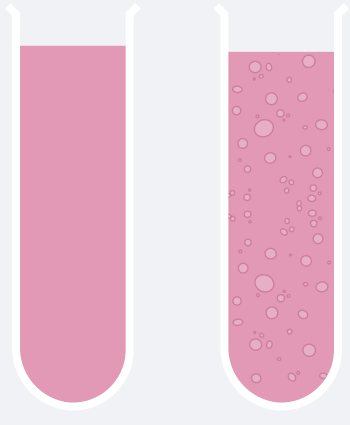
Pectin test in juice

Alcohol test

- Pour 5 mL juice sample in a test tube (in juice containing mix-beverages, accordingly more)
- 5 mL Ethanol (96%) zugeben
- Mix sample carefully; do not shake!
- Look out for quick rising bubbles/wait for a few minutes

Pectin proof

- A floating gel indicates higher amounts of pectin
- Slowly rising bubbles are an indicator of residual pectin



pectin free not pectin free

Enzymatic protein degradation

Sweet and sour cherries are not berry fruit, but are harvested at the same time and the fruit is processed on the same lines. The most well known is sour cherry juice, whose production and composition differs from berry juices. Sour cherries have less pectin than most berries, but more protein. The heat-stable protein can coagulate and remains in the pomace when mashed in without pectinase at > 70 °C. The protein content can be so high, though, that the bentonite required to stabilise the protein far exceeds the norm and the associated amount of turbidity is disproportionate.

In such cases, dosing the acid protease **Distizym® PROTACID** or acid protease–arabanase formulation **Fructozym® UF** can degrade the protein to such an extent that lower bentonite dosages can be used. In view of the finished juice's stability to be achieved, it is possible to dispense with the use of bentonite as a protein adsorption aid in very few cases, though.

Clarification and stabilization of juices

Clarification and stabilization are also combined under the term "fining" and are performed on the pectin-free juice. Fining is necessary to inhibit secondary turbidity in juices, nectars or other mixed drinks, such as mixed tea and fruit juice drinks, when bottling and for the duration of the best before date. It also has a positive effect on taste, odour and appearance, as a result of proportional adsorption of bitter substances and oxidised colour pigments. Fining agents therefore clarify and stabilise. The reaction in the beverage is based on adsorption and precipitation processes due to the molecules' charge balance. No fining agents are left in the beverage and are therefore regarded as a processing aid, like enzymes. It is possible to reduce the amount of filtration agent and mechanical stress on tangential flow filters as a result of fining agents' clarifying effect. This consequently minimises oxygen absorption and resulting oxidation of anthocyans for coloured fruit juices.

„Classic fining"

Classic fining is understood to be the use of bentonite, silica sol and the protein of animal origin, gelatine. Customarily a mixed bentonite, such as **Aktivit** or **NaCalit® PORE-TEC**, is added first. These bentonites work over a very wide range of pH values, so the user does not have to switch between different special bentonites. For efficient application, bentonite should be pre-swollen beforehand for several hours.

After the bentonite has been mixed in thoroughly, edible gelatine **ErbiGel®**, which has previously been dissolved in warm water, is stirred in. Silica sol is added as the final fining agent, to avoid overfining with gelatine. **Klar-Sol 30** can be used for pH values > 3.3. Acid silica sol **Klar-Sol Super** is more efficient than alkaline **Klar-Sol 30** at pH values below 3.3.

After the flakes have settled, the clarified supernatant can undergo filtration, on the one hand to achieve the beverage's desired cloudiness, and on the other to ensure separation of the flocculated fining agent.

Factors responsible for successful fining

Temperature

The reaction of treatment agents, and enzymes, is temperature specific. Inadequate reaction speeds and fining results should be expected at temperatures below 10 °C, with a fraction of the time being required for the desired reactions at higher treatment temperatures. This advantage is used during what is known as "hot clarification"; frequently at 50–55 °C work is carried out within a temperature range which optimally supports the ability of both enzymes and treatment agents alike to react.

Viscosity

Viscosity is closely connected with temperature. During hot clarification the juice's viscosity is reduced by the high treatment temperatures. The fining flocculate that forms can settle more quickly compared to cold clarification.

pH value

Depending on the pH value present, the charge intensity of the treatment agents varies, as well as that of the lees, which contain tannins and proteins. This is caused by the change in the isoelectric point. If the juice has a low pH value, e.g. pH 3.0, the molecules exhibit a very high charge intensity and therefore have good reaction properties, whereas charge intensity and consequently reactivity decrease with rising pH value. The pH value present therefore decisively influences the choice and application of bentonite, gelatine/plant-based fining protein and silica sol/ tannin .

Quantities of treatment agent

As the content of substances to be removed fluctuates in exactly the same way as the ratio of sediment to be taken up, it is recommended that preliminary tests be performed, at least for different raw materials. The anticipated colloidal stability can be measured using the hot/cold test.

Treatment agent sequence

Although the order in which treatment agents are applied can vary to a certain extent, predominantly bentonite is added first, followed by gelatine and silica sol. For beverages with a particularly low pH value, including citrus juices, clarification usually takes place with bentonite and silica sol only.

Fining tanks

The best sedimentation is achieved in fining tanks whose ratio is 1:2.5 diameter to height. If it is not possible to adhere to this ratio, the height should increase rather than the diameter.

Mixer

Slow-running paddle mixers which ensure even blending of the beverage and therefore gentle introduction of the fining agent are optimum. Fast-running propeller mixers are not appropriate in fining tanks! They destroy the fining agglomerate which forms, which leads to a slower deposition speed and the formation of fine sediment.

	Turbidity			Δ NTU as an indicator of stability
	[NTU]	after heat [NTU]	after cold [NTU]	
Apple juice(1)	1	1,3	1,5	≤ 1
Cherry juice(2)	2,5	3,0	3,8	≤ 2
Black currant juice(3)	4	5	7	≤ 5

(1) Pome fruit: Keep warm for 14 h at 65 °C -> freeze and thaw again
(2) Stone fruit: Keep warm for 10 h at 65 °C -> freeze and thaw again
(3) Berry fruit: Keep warm for 6 h at 65 °C -> freeze and thaw again

Vegan fining

It is essential that pork gelatine is not used for production of vegan, kosher or halal fruit juices. Plant-based pea protein **FloraClair®** represents a valuable alternative to gelatine. Neutral tasting, gluten and allergen free, pea protein wins out over other phytoproteins. As **FloraClair®** does not dissolve fully like gelatine, the process has to be modified slightly compared to "classic fining" with gelatine. Like bentonite, **FloraClair®** is pre-swollen and should be stirred into the juice for around one hour, for better reaction in the juice. These can even take place at the same time as pectin degradation.

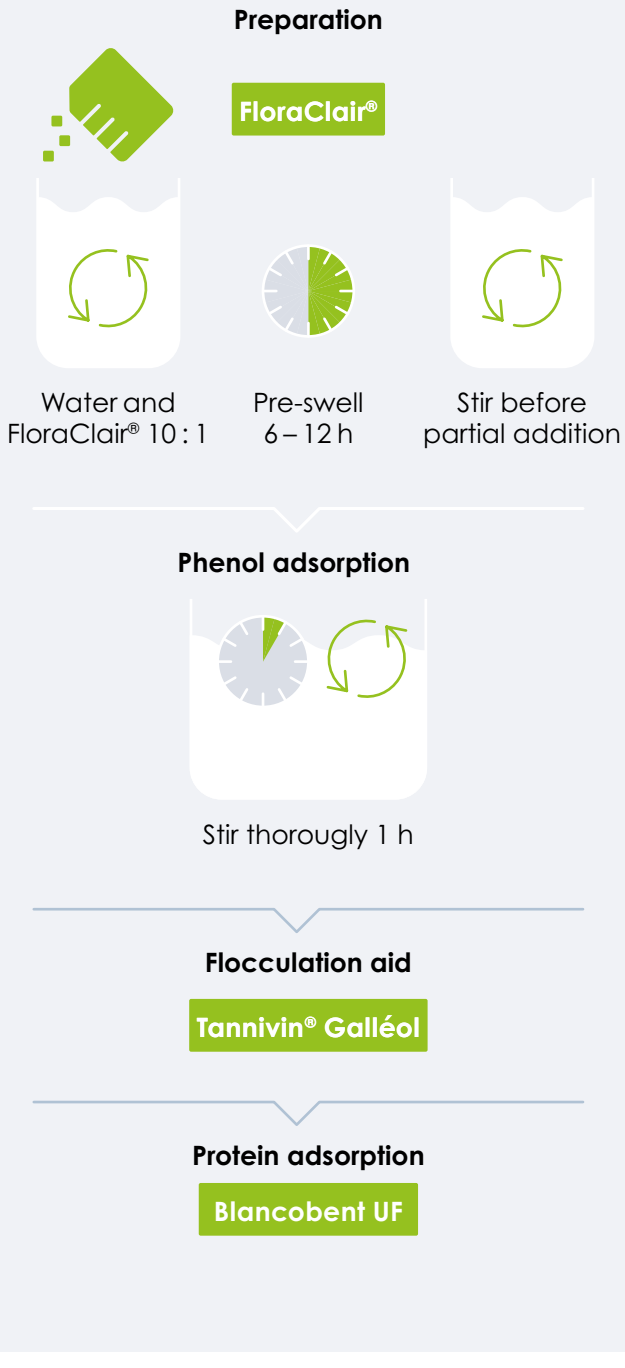
Plant-based fining tannin **Tannivin® Galléol** is added to the juice (dissolve in warm water beforehand) to achieve more intensive flocculation and therefore less turbidity in the sedimentation supernatant. **Tannivin® Galléol** should also be stirred in thoroughly. As tannins do little to inhibit enzymatic reactions, dosage can take place together with **FloraClair®**, during pectin degradation

After around one hour contact time, during which fining is kept in motion using the mixer (slow or occasional stirring), primed bentonite **Blancobent UF** or **UltraBent PORE-TEC UF** is stirred in. Both bentonites are more active than classic mixed bentonites and, in addition to forced flocculation, also cause rapid sedimentation. For businesses which use crossflow filtration, the possibility arises here, with a suitable filter system, of directly filtering off the fining without prior sedimentation.

Advantages of vegan fining

- Vegan, kosher and halal certification possible
- **FloraClair®** is not fully dissolved, reducing the risk of overfining
- **FloraClair®** can be used up to three working days under hygienic conditions
- There were no time disadvantages as a result of the different procedure
- The fining can be promptly filtered off using a crossflow filter

FloraClair® – the full alternative to gelatin for vegan fining



Our products
for your coloured fruit processing

	Description	Application	Dosage*
Enzymation of mash and pectin depectinisation			
Fructozym® Color	Acid resistant special pectinase, colour protecting for sensitive pigments	Strawberry, raspberry, elderberry	10–300
Fructozym® BE	Pectinase with special glucanase	Raspberry, blackberry, strawberry	30–200
Fructozym® EC Color	Concentrated acid tolerant pectinase	Black currant, elderberry, sour cherry	5–200
Degradation of colloids and proteins			
Fructozym® FLUX	Broad spectrum pectinase, rich in glucanase	Optimized filtering of fruit juices	30–60
Fructozym® UF	Pectinase and acidic protease	Improved stability for sour cherries and elderberries	5–150
Fructozym® Flow UF	Concentrated pectinase and hemicellulase	Pectin breakdown and improved filtration for all fruit juices	5–30
Distizym® PROTACID	Acidic protease	Improved stability of sour cherry	20–100
Clarification and stabilisation			
NaCalit® PORE-TEC	Highly purified special bentonite	Production of fruit juice with highest purity specifications	500–2.000
Aktivit	Granulated bentonite for beverage treatment	Protein fining and clarification	500–2.500
Blancobent UF	Special bentonite, free from coarse particles	Inline stabilisation in crossflow filter systems	500–2.500
ErbiGel®	Fining gelatin	Tannin adsorption	100–400
FloraClair®	Vegetable fining protein	Tannin adsorption, suitable for halal, kosher and vegan products	100–600
Klar-Sol 30	Alkaline silica sol for beverage treatment	Complexation of protein and excess gelatin	1.500–3.500
Klar-Sol Super	Acidic silica sol for beverage treatment	Complexation of protein and excess gelatin at pH < 3.2	1.500–3.500
Tannivin® Galléol	Fully hydrolyzable tannin from oak apples	Beverage fining	20–50

*g or mL/1.000 L

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