

Cider Production in England and France – and Denmark?

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Abstract

In many countries cider is available as an alternative to beer or to wine. In Denmark only the low/non alcoholic type is widespread available. With the aim of possible production in Denmark cider making was studied in England (Herefordshire and Somerset) and in France (Normandy and Brittany). A short literature survey is introducing the description of the English and French producers visited. The paper ends with a suggestion for potential cider production in Danish breweries.

Keywords

Cider, apples, England, France, literature survey

Introduction

This study tour was made possible by receipt of a travelling fellowship from the Danish Brewers' Association/ Ulrich Brinch and Wife's Memorial fellowship granted by the Danish Brewers' Guild. The purpose was to study cider production in England and France in order to suggest a possible way of producing cider in Denmark. 8 producers in England and 4 in France were visited. The aim was to visit large as well as small producers and traditional as well as modern production plants.

Literature Survey

A short survey of the past decades literature was performed as an introduction to the study tour. Reference is made to the literature listed at the end of the paper. Literature reviews of the cider making process have previously been provided by other authors^{2,16} and good overviews can also be found on the internet^{7,11,20}. Good descriptions for small scale cider makers are also available^{25,27}.

The vast majority of literature on cider making and research is written by research scientists in the main cider countries England, France and Spain.

Definition of Cider

Cider can be defined as a fermented, alcoholic beverage made on apple juice. The term 'cyder' is also used in England indicating very traditional production methods. 'Scrumpy' is a term also used to indicate a traditional, but normally unfiltered hazy product without CO₂. Cider can be distilled into cider brandy or acetified into cider vinegar. In France the cider brandy is called 'Calvados' or 'alambic' depending on the place of origin. In France a blend between cider and cider brandy is matured in oak vats into a dessert wine product called 'pommeau'. A product similar to cider is perry, which is made on pear juice.

Schematic flow diagrams of the cider making process are given in Fig. 1 and 2.

Cider Apples

In England (west and south-west), France (north-west) and Spain (north-west) true cider apple varieties are grown. Cider apples are smaller than dessert and cooking apples and more like wild apples.

Fig.1: Production of apple juice and concentrate from cider apples.

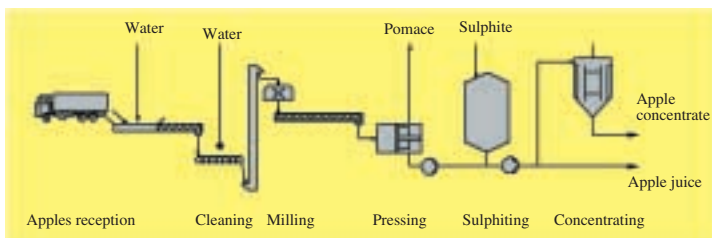
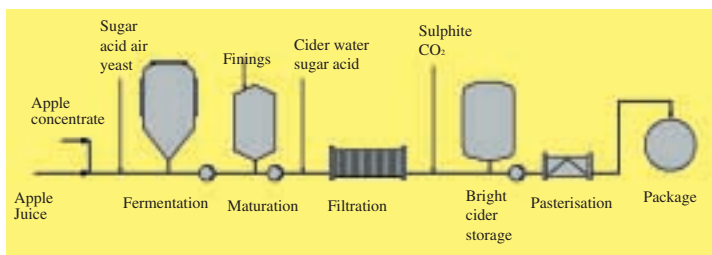


Fig. 2: Production of cider from apple juice or concentrate.



Cider apples are traditionally grown in orchards together with grazing cattle, sheep's or horses. Before the apples are mature, the creatures are removed. The mature apples fall to the ground and the last apples are picked from the trees. Traditionally, the apples were hand-picked, but in modern orchards the trees are shaken so that the apples fall to the ground, where they are mechanically harvested.

In several orchards dwarf trees with a low trunk are grown. These trees can be planted very close to each other thus achieving a much higher yield per area.

Generally, cider apples have an acidic and bitter/astringent taste and are categorized into 4 groups after acidity and tannins as can be seen from Table 1. The acidity is mainly due to malic acid, whereas the bitterness is due to tannins (polyphenols). Dessert apples typically contain below 0,1% tannin and the cooking apple variety Bramley contains ca. 0.05% tannin and ca. 1.5% acid ¹⁹.

Cider Apples	Acid < 0,45 %	Acid > 0,45 %
Tannin < 0,2 %	Sweet	Sharp
Tannin > 0,2 %	Bittersweet	Bittersharp

Table 1: Classification of cider apples in England ^{19,23}.

More than 70 cider apple varieties are available in England 23 and fewer varieties are available in France. Names on some apple varieties, used by the producers visited is listed in Table 2 for England and in Table 3 for France.

The phenolic compounds in cider apple varieties are mainly located in the skin and found primarily to be monomer flavanols and oligomer and polymer procyanidins build by epicatechin-units ^{12,19,26,30,31}. The flavanols

Sweet	Morgan Sweet *), Sweet Alford, Sweet Coppin, Taylor's Sweet
Sharp	Brown's Apple, Frederick
Bittersweet	Ashton Bitter, Brown Snout, Brown Thorn, Bulmer's Norman, Chisel Jersey, Dabinett *), Ellis Bitter, Harry Masters Jersey, Improved Dove, Médaille d'Or, Michelin, Reine des Pommes, Somerset Readstreak *), Tremlett's Bitter *), Vilberie, Yarlington Mill
Bittersharp	Breakwell's Seedling, Foxwhelp *), Kingston Black *), Porter's Perfection, Redstreak, Stoke Red *)
Dessert Apples	Cox's Orange *), Katy (Katja) *)
Cooking Apples	Bramley's Seedling, Grenadier

Table 2: Examples on English cider apple varieties as well as dessert and cooking apple varieties used in cider production in England.*) means varieties used for single variety cider.

Sweet	Bedan, Bisquet, Douce coetlignne, Tête de brebis
Sharp	Avrolles, Judaine, Judeline, Judor, Juliana, Petit jaune
Bittersweet	Binet rouge, Clos renaux, Douce moen
Bitter	Fréquin rouge, Kermerrien, Peau de chien

Table 3: Examples on French cider apple varieties used in cider production.

works as antioxidants ²⁶. Apart from the bitter and astringent taste the phenolic compounds gives the juice a darker colour when oxidised. Oxidation and fining with gelatine decreases the content of procyanidins in cider ¹⁹.

The sugars of cider apples are primarily fructose, glucose and sucrose and the acids are primarily malic and quinic acid ¹⁶.

Milling and Pressing

Upon reception in the cider plant the apples are blended and thoroughly washed with water. By blending different cider apple varieties a balanced sweetness, acidity and tannin content can provide the desired character of the cider to be made.

By milling the apples are broken down into pulp. Traditionally, the apples were beaten by a pole or squeezed by a stone running in a trough – the stone being driven by a horse. Nowadays, the most commonly used equipment are mills with rotating knives or hammer mills.

After milling the pulp is conveyed or pumped to the press. Traditionally, the pulp was spread by hand on a cloth, which was folded and several layers of these packages were stacked upon each other forming a so-called 'cheese'. The juice was extracted in a manually or hydraulically operated press. The most commonly used presses today are the belt press and the piston press. A high content of polyphenols in the apples makes an easier pressing and gives a higher juice yield ¹⁹.



Illustration of cider apples from 'The Herefordshire Pomona' (from www.cideruk.com)

After pressing sulphite is added to the apple juice and the juice is stored overnight in order to achieve an antimicrobial effect and prevent browning reactions. The recommended concentration is given in Table 4. If the pH in the juice is above 3.8 the acidity should be adjusted with juice from more acidic apples or with malic acid.

Juice pH	Sulphite concentration
< 3,0	0 ppm
3,0 – 3,3	75 ppm
3,3 – 3,5	100 ppm
3,5 – 3,8	150 ppm
3,8 – 4,0	200 ppm
> 4,0	Malic acid to pH = 3,8 and add 150 ppm sulfite

Table 4: Recommended concentration of sulphite in apple juice at various pH².

	Juice from Cider Apple	Juice from Culinary Apples
Specific Gravity	1,045 – 1,061	1,047 – 1,057
Tannin	1.0– 4.6 g/l	0.6 – 1.6 g/l
Total sugar	98 – 131 g/l	100 – 118 g/l
Total Nitrogen	76 – 267 mg/l	98 – 250 mg/l
Amino Nitrogen	13 – 106 mg/l	10 – 112 mg/l

Table 5: Content of apple juice used for cider making¹⁶

Sometimes the juice is treated with pectinase or fined in order to make a clear juice. Sulphiting, treating with pectinase and fining with bentonite is found to slow down alcoholic fermentation and, furthermore, sulphiting delays malolactic conversion in traditional Spanish cider⁹.

In France naturally sweet cider is made by a process called 'd'effécation'. By this process a Ca-pectate gel ('chapeau brun') is formed as a brown layer on the top of the juice and skimmed off. The Ca-pectate traps some of the nitrogen in the apple juice leaving insufficient nitrogen in the remaining juice for the yeast to ferment the sugar to dryness. It can happen naturally or can be induced by adding pectin esterase and calcium chloride. 'D'effécation' is reported to slow down alcoholic fermentation as well as malolactic conversion¹⁰ and to result in a better microbiological stabilised cider²¹. In traditional English cider making 'keeving' had the same effect when leaving the milled pulp overnight before pressing².

In English cider making chaptalization is the process of adding fermentable sugars to the juice¹⁶.

Fermentation

Traditionally, cider has been fermented and matured in oak vats or barrels. Today, many of the larger producers use stainless steel and/or lined mild steel tanks.

Many producers in England and France still make cider by spontaneous natural fermentation. The yeast is found externally on the apples skin as well as internally in the flesh near the eye and the stalk. Also yeasts from the process equipment play an important role. In natural English cider fermentations species such as *Kloeckera apiculata*, *Saccharomyces cerevisiae* and *Saccharomyces ludwigii* have been isolated as predominating². The predominant yeasts in French cider are found to be



Rotating hydraulic piston press
from Bucher-Guyer.

Saccharomyces cerevisiae, *Hanseniaspora valbyensis* and *Metchnikowia pucherrima*^{17,18,28}, while in Spanish cider the predominant yeasts are found to be *Saccharomyces cerevisiae* and *Kloeckera apiculata*^{3,4,5,8}. Yeasts of the genera *Zygosaccharomyces*, *Torula*, *Candida*, *Pichia*, *Brettanomyces* and *Hansenula* have also been isolated in addition to other species of the genera *Saccharomyces* and *Kloeckera*.

The most widespread used pure yeast cultures in cider production are *S. cerevisiae* isolated from cider or wine yeast strains. The yeast is not re-used as for beer fermentations. The pitching yeast should result in 2-4 Mio. cells/ml in the fermenting juice⁷.

The main flavour compounds produced during fermentation are organic acids, esters and higher alcohols. Succinic acid, malic acid and lactic acid are produced by the yeast². The formation of higher alcohols are found to be inversely correlated to the content of nitrogen in the juice³⁷ and to be suppressed by sulphite². Also sulphur compounds like hydrogen sulphide and dimethyl sulphide are important flavour compounds produced by the yeast. As for beer diacetyl is produced by the yeast, but also by the lactic acid bacteria associated with malolactic conversion³⁸.

In English cider making the fermentation takes place at 20-25°C for 1 to 4 weeks, whereas in French cider making the temperature is generally kept lower at 15-20°C and thus fermented for 1 to 3 months. Fermentation in tall tanks with hydrostatic pressure above 1.5 bar is reported to be slower and having a negative influence on the flavour¹⁶.

Maturation

Like in wine, cider sometimes undergoes a secondary malolactic conversion, whereby lactic acid bacteria convert malic acid into lactic acid. The sharp acidity of malic acid from the apples is substituted by the more soft acidity of lactic acid. The responsible lactic acid bacteria are found in the oak vats³⁶. The predominant lactic acid bacteria are found to be *Lactoba-*

cillus plantarum in English cider vats³⁵ and *Leuconostoc oenos* in French cider^{17,18,28}. In Spanish cider *Leuconostoc oenos* and *Lactobacillus* species have been found responsible for the malolactic conversion^{8,29}. Other lactic acid bacteria belonging to the genera *Lactobacillus*, *Leuconostoc* and *Pediococcus* have also been identified. The malolactic conversion is reported to appear above 1 Mio. cells/ml of lactic acid bacteria^{8,18}. It has not come to the author's knowledge that pure cultures of lactic acid bacteria are used in any commercial production plants.

Malolactic conversion was obtained applying pure cultures of *Oenococcus oeni* (former *Leuconostoc oenos*) added after the main fermentation in trials at the author's private premises¹. The conversion took 11 days without sulphiting the juice before the main fermentation and up to 21 days if up to 60 ppm sulphite was added before the main fermentation.

In English and French cider making the malolactic conversion takes place after the alcoholic fermentation, whereas in Spanish cider it is reported to take place simultaneously with the alcoholic fermentation^{8,29}. Inoculation with pure yeast and bacterial cultures in Spanish cider show that sequential fermentations are preferred to simultaneous fermentations¹⁴. The maturation normally takes from 1 to 4 months, but up to 2 years are practised.

Apart from malic and lactic acid other organic acids play an important role during maturation. Quinic acid and shikimic acid are converted to dihydroshikimic acid. Acetic acid and succinic acid is produced by the lactic acid bacteria³⁸. Even a decrease in lactic acid has been observed^{13,15}.

The optimal storage temperature for English cider was found to be 15°C³⁴ and to be 22°C for Spanish cider^{13,15}. In England the cider is normally matured at room temperature, while in France the temperature is lower at 10-15°C. Dissolved oxygen in the cider during storage was found to give undesirable oxidation flavours. Re-constituted concentrate was found not to promote the desirable flavour changes as fresh apple juice did, due to the lack of malolactic conversion³⁴.

Successful laboratory trials have been performed with immobilization of yeast and lactic acid bacteria in order to obtain simultaneous alcoholic fermentation and malolactic conversion. *Saccharomyces cerevisiae* and *Lactobacillus plantarum* have been co-immobilized on a sponge-like matrix³³, *Leuconostoc oenos* has been immobilized in Ca-alginate⁶ and *Saccharomyces bayanus* and *Leuconostoc oenos* have been co-immobilized in a Ca-alginate matrix²⁴. However, a lower content of higher alcohols and a higher content of diacetyl have been found²⁴.

Post Fermentation

After maturation it is often necessary to stabilise the cider. Bentonite is most widespread applied for fining/stabilisation, but also isinglass, chitin, kieselguhr, gelatine and albumin are applied. It is mainly the proteins, which are undesirable, because the phenols give the cider the typical cider-phenolic flavour.

Sulphite is often added and the cider is filtered. Cross-flow filtration is the most common filtration method in England, while kieselguhr filtration is more widespread used in France.

Different ciders are blended into the desired final brand. The acidity can be adjusted by adding malic acid and priming sugar as well as carbon dioxide can be added to the cider.

A secondary fermentation by yeast in the bottle is commonly applied in order to carbonate the cider.

'White cider' is a special type of cider, where either the juice or the fermented cider is filtered through a carbon filter. The cider becomes almost clear as water and some of the flavour compounds also disappear. The typical alcohol content of 'white cider' is 7,5-8,5 % v/v.

Cider Off-Flavours

The following off-flavours can be found in cider:

- Infection by the bacterium *Zymomonas anaerobia* cause so called cider sickness by its production of acetaldehyde and haze formed with polyphenols².
- A peppery off-flavour and unpleasant bitter taste can originate from the lactic acid bacteria *Lactobacillus collinoides*. The off-flavour is due to acrolein produced by the bacteria from glycerol^{32,38}.
- A mousy off-flavour is found in ciders infected with *Brettanomyces* or certain lactic acid bacteria².
- If oxygen is available there is risk of acetic acid production from ethanol by *Acetobacter*.

The polyphenols from the apples are inhibitory towards possible infecting microorganisms.

The English National Association of Cider Makers has compiled a flavour wheel corresponding to M. Meilgaards flavour wheel for beer. Most of the descriptors are the same, but the acidic impression is described in more detail¹⁶. Because of the cumulative effect of the astringent impression of a high content of polyphenols a special evaluation technique is required¹⁹.

Acidic polysaccharide and propanol have been found responsible for the foaming properties of cider²².

Cider Production in England

The 6 Mio. hl per annum British cider market is dominated by 2 producers: H.P. Bulmer and Matthew Clark.

Together they have more than 80 % market share. There are 4 medium sized producers: Knight's, Thatcher's, Weston's and Merrydown. Furthermore, there are about 200 smaller cider producers using traditional methods and having a small annual production.

The English cider production is concentrated around the counties of Somerset and Herefordshire, except for Merrydown in Sussex and many smaller producers.

The British cider market is the largest in the World and 6.5 % of the British drinks market is cider and perry.

The cider producers visited are indicated on the map below.



Map of England showing the 8 producers visited.

H.P. Bulmer

Percy Bulmer started in 1887 cider production in Hereford and Bulmer has now become the Worlds greatest producer of cider. The annual production (1999) is 2.7 Mio. hl (60 Mio. gallons) cider. Bulmer also has production plants in Ireland, Belgium, Australia, New Zealand, South Africa, China and USA. The policy of Bulmer is to deliver any of their products anywhere in UK within 48 hours.

During the years 1992-96 Bulmer has invested £ 21 Mio. on a thorough modernisation and automation of their plant in Hereford, which is also the head quarter of the Bulmer Group. The tank farm is listed in Table 6 (see next page).

Bulmer's 3 main cider brands are Strongbow, Woodpecker and Scrumpy Jack. Scrumpy Jack is produced by the sister company Symonds Cider although it is not real scrumpy in traditional terms. Other brands are Max, King Acre, Bulmers Traditional, Old Hazy and 1727. The last one is made on dessert apples.

Bulmer gets cider apples from more than 2,400 ha (6,000 acres) of orchards, which partly are owned by Bulmer and partly by local farmers on contract. 75 % of the cider apples grown in England are grown in Herefordshire for Bulmer.

Apple Concentrate Tanks	6 x 2.352 hl stainless steel
Fermentation and Maturation Tanks	11 x 6.750 hl, 13 x 2.250 hl stainless steel
Bright Cider Tanks	10 x 1.800 hl, 2 x 900 hl stainless steel
'Planet'-Tanks for Apple Concentrate and Cider	1 x 72.700 hl, 2 x 50.000 hl, 8 x 25.000 hl epoxy- lined mild steel

Table 6: The tankfarm at H.P.Bulmer.

The apples are received in concrete hoppers and flushed with water to the mill. 1,500 tons are treated per day corresponding to 60,000-80,000 tons per year. The pulp is pumped into an automatic belt press (make Gebr. Bellmer), where the juice is pressed from the pulp under increasing pressure. The pomace is sold to the company Hercules for recovery of pectin. Sulphite is added to the juice, which is then concentrated down to an 8.5:1 ratio in an evaporator (make Unipektin).

Prior to fermentation the juice is pasteurised in order to prevent natural fermentation. Bulmer uses 3 different yeast strains: a traditional yeast, a general purpose yeast and a yeast used for conditioning. The fermentation takes place at 22°C for 2 weeks. Temperature control is done via external heat exchangers. The carbon dioxide is collected and recovered. The cider matures for 1 month. Bulmer no longer uses oak vats, but tanks in stainless steel and mild steel with epoxy lining. One of the tanks of 72.700 hl (1,6 Mio. gallons) is in the Guinness Book of Records as the biggest drinks container in the world.

After maturation the cider is filtered through 3 continuous membrane micro filters (make Memcor). 6 different basic ciders are made and blended into all the brands. The sweetness and the acidity is adjusted by adding sugar or malic acid. Finally, the cider is flash pasteurised and carbonated. From bright cider tanks the cider is filled into glass bottles, PET bottles, cans and kegs. The cider in cans is tunnel pasteurised.

The production plant in Hereford has a high degree of automation and many leak proof valves (make Tuchen-hagen) are installed.

Matthew Clark

In 1995 Matthew Clark bought and merged Tauton Cider in Taunton and Gaymers' in Shepton Mallet to become the second biggest cider producer in UK. The entire cider production has now been relocated to a new upgraded plant in Shepton Mallet in Somerset and the plant in Taunton has been closed down. Matthew Clark produces more than 2,2 Mio. hl cider per year. During the past 4-5 years £ 40 Mio. have been invested.

Matthew Clarks brands are Olde English from Gaymer, Blackthorn and Diamond White and Diamond Red from Taunton and the new brands K and K6.

The majority of the apples are purchased on contract from local farmers, but some are bought on the spot market. The apples are received in 6 concrete pits each with a capacity of 75 tons. 70-75 tons of apples can be received per hour and the apples are stored for not more than 16 hours in the pits. The apples are conveyed in a stream of re-circulating water via an en pit, where stones and rotten apples are removed, to a roller belt, where they are sprayed with water in order to remove grass and dirt. The apples are conveyed by a screw auger to the mill, where 3 rotating hammers cut the apples into 1/2 cm cube lumps. The pulp is pumped to buffer tanks (5 of 8 tons each), where they are stored for not more than 1 hour. The entire apple intake system is fully automated.

The pulp is pressed in a computer controlled Bucher-Guyer press with a capacity of 12 tons fruit in 1 1/2-2 hours. The apple pulp is introduced into a drum in which there are 240 perforated elements (hoses). The pulp is pressed using a piston and the juice runs through the hoses to be pumped away. The drum rotates during pressing and pressure is applied for 1/2 min. and released for 1 min. 1 ton of apples yields 750-800 l juice.

In order to get a uniform product all juice is concentrated within 24 hours from 11-14 °Brix to 71 °Brix. Before concentrating sulphite is added to the juice. Concentrate is also bought from other suppliers.

2 yeast strains are used – a Gaymers yeast and a Taunton yeast. The juice is aerated in-line with compressed air and the acidity is adjusted with malic acid before fermentation. Fermentation takes place at 20-23°C in cylindro-conical stainless steel tanks with agitator and temperature control. At the end of fermentation after 6-10 days the cider is cooled down to 10°C and the yeast is collected and given to farmers pigs. Sulphite and finings (isinglass, chitin) is added in the tank and let stand for 2 days. The tank farm consists of 14 fermenting tanks each 2,000 hl and 15 each 1,000 hl. The secondary malolactic conversion is not wanted and therefore not achieved. The semi-bright cider is stored in buffer tanks before blending and filtration.

7 basic ciders are produced and blended into the brands blending area. Water from own boreholes is also added (high gravity cider). The water is not deaerated, because oxygen is not considered any problem. Further-

more, sugar or apple juice is added in order to adjust the sweetness and malic acid or citric acid is added for adjustment of acidity. Finally, colour (caramel) and sulphite is added. The blended cider is transferred to buffer tanks.

The cider is filtered through a cross-flow filter with a $0,2 \mu\text{m}$ pore size. The cider is cooled down to -2°C and carbonated. Carbon dioxide from the fermenting tanks is not collected. The cider is stored in bright cider tanks (13 each 550 hl) before packaging.

The cider is filled into small non-return glass bottles (600 bottles/min.), 1 l non-return glass bottles and 3 l non-return PET bottles (200 bottles/min.), cans (720 cans/min.) as well as 50 l kegs (800 kegs/hour).

The plant has a high degree of automation with leakage proof valves (make Tuchenhagen).



Cross-flow filters at Mathew Clark.

Westons

Westons Cider is situated in the small village Much Marcle in Herefordshire and was started in 1880 by Henry Weston. The best known brand is Stowford Press, but vintage cider, perry and Marcle Millennium are also made. The last one being a blend between cider and perry. Cider with ginger and lemongrass flavours are also made. The production in 1999 was 50,000 hl.

Westons own 61 ha (150 acres) orchard with cider apples and pears and they buy fruit from another 121 ha (300 acres) by appointment with local farmers. All orchards are within a radius of 25 km from Westons. 4,000 tons of apples are treated annually.

During the harvest season the apples are received in a 60 ton hopper and flushed with water into a screw auger.

The water circulates over the reception hopper and is drained every 8 hour. The effluent is cleaned in their own reed bed plant.

The stones are removed and the apples are washed, milled and pressed. During the visit buildings for the mill and the press were being renovated in order to make room for a second hand Bucher-Guyer press purchased to substitute the old belt press. 50-80 ppm SO_2 is added in-line to the apple juice, which is stored in glass fibre tanks for 12-24 hours in order to get the sulphite working and to measure the extract for customs. The juice is not pasteurised because of the damage to flavour. If their own juice production is too little, Westons buy concentrate from outside.

The juice is fermented in oak vats with capacities ranging from 50 to 2,000 hl, the oldest being up to 200 years old. The fermentation takes place at ambient temperature for 3-4 weeks. If the temperature gets too low, the juice can be heated by pumping hot water through a hose in the tank. The aim is to ferment at as low a temperature as possible without stopping the fermentation. Westons use a pure yeast culture. Glucose is added in order to achieve an alcohol content of 10,5 % v/v. Using apples alone can only achieve 5-7,5 % v/v alcohol. In the oak vats the secondary malolactic conversion by lactic acid bacteria is achieved. The cider is stored in fibre glass or stainless steel tanks.

Westons does not concentrate the apple juice and, therefore, has to use it as soon as possible after pressing. That means that fermentation only takes place during the period September to January.

Westons makes 6 different cider bases, from which all their brands are blended. Sugar or saccharin and malic acid is added to adjust the sweetness and acidity. The matured cider is filtered through an automatic $0,2 \mu\text{m}$ pore size cross-flow filter (make Memcor) into an oak vat. Before blending the cider is cooled to $3-4^\circ\text{C}$ and filtered through a series of cartridge filters with pore sizes of $15 \mu\text{m}$, $1 \mu\text{m}$ and $0,8 \mu\text{m}$ into a buffer tank. Most of the production is then filtered through a $0,45 \mu\text{m}$ membrane filter to a bright cider tank. The last filtration is not done for the low alcohol products or the hazy scrumpy's, which are pasteurised.



Glass jars for scrumpy at Westons.

The cider is packaged in 6 different glass bottles or kegs in Westons own packaging, but cider is also taken away in road tankers for filling cans and PET bottles elsewhere. Furthermore, the still scrumpy is hot filled at 65°C in 1750 ml glass jars.

Thatchers

Thatchers is a completely family owned business producing 90-100,000 hl cider per year. Thatchers owns 70 ha (170 acres) cider apple orchard, but apples are also bought from nearby farmers. Thatchers also treats other kind of fruits. A lot of the apples are stored as concentrate.

Thatchers produces several single variety ciders: Cox, Dabinett, Tremletts Bitter, Somerset Redstreak, Katy and Morgan. Cox and Katy are dessert apples.

The apples are received in a pit and flushed with water to a tank where stones are caught. The apples are conveyed over a roller belt, where they are sprayed with water. The mill and the press are modern equipment from Bucher-Guyer. 3 new and 2 old Bucher-Guyer presses with a total capacity of 20 tons/h (400



Oak vats at Thather's.

tons/day) are installed. Sulphite is added to the juice and let stand 24 hours before pitching. Glucose syrup or invert sugar are added to some ciders. Some of the apple juice is concentrated and stored for later use.

The fermentation takes place in stainless steel tanks (8 tanks each 682 hl) or glass fibre tanks (8 tanks each 682 hl). All tanks are cooled by glycol in cooling coils inside the tank. The temperature is maintained at 20°C during the fermentation, which last for about 20 days. Pure yeast cultures are used for the alcoholic fermentation and the secondary malolactic conversion does not happen. Sometimes the juice pH is adjusted to just above 3,8 with acidic apple juice (e.g. Bramley) or with malic acid. It is not necessary to aerate the juice, but seldom it is necessary to add nutrients especially when using old concentrate.

The cider is matured in oak vats (11 vats with total capacity of 5,546 hl) for up till 4-6 months for some brands. Sometimes it is necessary to fine the cider with bentonite or kieselguhr or by centrifugation. The cider is filtered through a plate and frame filter or a cross-flow filter (0,6 µm). For environmental reasons Thatchers does not apply kieselguhr filtration. Finally, sulphite and carbon dioxide is added. One product is pasteurised and only the natural draught cider is not carbonated.

The cider is made a little stronger than the final brand and adjusted with filtered water. Oxygen is not considered to be any problem for cider.

Thatchers had installed new bright cider tanks and the cider is filled in bottles or kegs.

Sheppy's

Sheppy's is one of the bigger farm cider producers with an annual production of around 4,500 hl (100,000 gallons). Cider production was started by Richard Sheppy in 1780 and the traditional methods are still applied.

The apples are exclusively from the farms own 17 ha (42 acres) cider apple orchard and concentrate is not used. The apples fall to the ground and picked with an automatic harvesting machine.

After milling the pulp is pumped into a hopper above the press, which has 3 trays in a clover leaf formation. In the first tray the pulp is spread by hand on cloths alternating with partitioning plates forming 30 layers to a 'cheese'. The tray is turned to its second position, where the tray is pressed upwards with a hydraulic pressure of 100 tons for 20 minutes. In the third position the pressure is increased to 300 tons for 20 minutes. Returning to the first position the pomace is removed and used for cattle feed. Pressing of 1 ton of apples yields ca. 820 l (180 gallons) juice.



The clover leaf apple press at Sheppy's.

The natural and spontaneous fermentation takes place in oak vats for 10-14 days. A secondary fermentation takes place before the cider is blended into the final product.

Sheppy's makes single variety cider from Tremlett's Bitter, Kingston Black and Dabinett, but also blends of different varieties into dry, medium and sweet cider with alcohol ranging from 6-8 % v/v.

Perry's

Perry's has been a family owned business for more than 500 years. The annual production is ca. 2,000 hl. The apples are handpicked from the ground in the farms own apple orchard and tipped into a pit. The apples are washed with water and conveyed by an elevator to the mill consisting of high speed rotating stainless steel knives. The pulp is pressed in a traditional 'cheese' in a wheeled trolley. 9 layers are build and pressed with 1,500 kg. The pomace is used for cattle feed.

The juice ferments by spontaneous fermentation for 4-8 weeks depending on the temperature. Maturation takes place in 120-140 gallon barrels. Vintage cider is matured for up to 2 years. The cider is filtered and pasteurised. Perry's makes dry, medium dry and medium sweet cider.

Burrow Hill Cider

Burrow Hill is a farm cider producer with an annual production of 4,500 hl cider (100,000 gallons). Only cider apples from the farms own orchard of 53 ha (130 acres) is

used. 40 different varieties are mixed and Stoke Red and Kingston Black are used for single variety cider. Sweet, medium and dry ciders are made.

The press is made of wood and a traditional 'cheese' is build. Sulphite is added to the apple juice and then pitched. The fermentation takes place in 227 hl and 455 hl (5,000 and 10,000 gallons) oak vats at ambient temperature –a cold autumn is preferred. The fermentation and maturation last for 3 months. During maturation the malolactic conversion is achieved. The cider is filtered in a sheet filter and pasteurised except for draught cider. Some cider goes through a fermentation in the bottle in order to produce carbon dioxide.

The company is best known as Somerset Cider Brandy Company. The finished cider is distilled and the alcohol is stored in oak vats for 3, 5 or 10 years. The permit for distillation was given in 1989 so the first 10-year cider brandy became available in January 2000.

Minchew's

Kevin Minchew started in 1993 commercial production of cider and perry.

The production is very traditional and takes place in some wooden huts on his parents farm. Only pure apple juice from true cider apples are used and without any additives at all. The apples are washed with water in a tub and crushed in a mill made of a wooden cylinder with screws at different heights. The apple pulp is spread onto polypropylen cloths, folded and stacked to a 'cheese' and pressed in a traditional screw press. The juice is poured into 40 gallons oak vats and fermented spontaneously. Fermentation/-maturation lasts for up to 31 months for certain perrys. Fermentation is best at ca.15°C and this is achieved



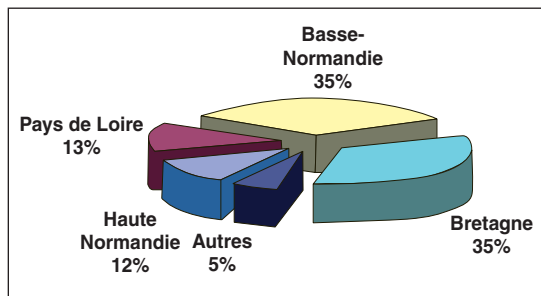
Kevin Minchew at his oak vats, where he makes traditional cyder.

by spraying the vats with water during the summer season and by heating the room during the winter season. The finished cider is filtered through a 0,45 µm sterile filter before filled on 75 cl bottles with cork. The malolactic conversion is not achieved.

Minchew produces ca. 750 gallons (34 hl) apple cider and the same amount of perry per year. He has specialised in single variety cider and perry. As for cider apples pear varieties exists especially suited for perry. The cider is traditionally without carbon dioxide, even though one product is artificially carbonated. The production is sold to restaurants and speciality shops and Minchew has since 1993 been awarded numerous prizes for his ciders and perry at the yearly competition at Museum of Cider in Hereford.

Cider Production in France

The French cider market is 1,1 Mio. hl. (1999). There are 50 main producers, of which 10 makes more than 85% of the production. 82% of the cider is produced in Brittany (Bretagne) or in Normandy.



Cider production in the different regions of France (from www.info-cidre.com).

The following terms are useful for French ciders:

- ‘Cidre fermier’ means that the cider originates from a farm using apple from its own orchard (‘verger’).
- ‘Cidre bouché’ means that the cider has a natural sweetness from residual sugar after fermentation having been fermented in the bottle to carbon dioxide.
- Some cider in France is also labelled AOC (‘Appellation Origin Contrôlé’).

The producers visited are indicated below on the map of Normandy and Brittany.

Loïc Raison

Loïc Raison is situated in Domagné in Brittany and is owned by Pernod Ricard being the biggest producer of cider in France. Pernod Ricard owns further 3 big cider production plants and some minor farm cider makers,



Map of Normandy and Brittany showing the cider producers visited.

but Loïc Raison is the biggest with an annual production of 300,000 hl or 30 Mio. bottles. In addition to cider, apple juice is made.

The cider apples are grown by a cooperative with 10 % shares owned by local farmers. Most of the varieties are French, but also the English Dabinett is used. The apples are harvested mechanically by shaking them from the trees and 1,000 tons of apples are received and treated daily in the season. The apples are milled in a mill with rotating knives and pressed in a Bucher-Guyer press at 6-7 tons/hour. Most of the pomace is sold for pectin recovery and the rest is used for fodder.

In France it is permitted to add up to 10 % concentrate to ‘cidre’, but neither sugar nor colouring is allowed. If they call it ‘cider’ it is allowed to add acid, sugar and colourings.

‘Défécation’ takes place in open vats for a week. Enzymes and CaCl₂ are applied in order to initiate the process.

The spontaneous fermentation takes place in stainless steel tanks or glass fibre tanks at 15-20°C for 3 weeks without any cooling. The cider is matured at 13-14°C in



Kieselguhr drum filter for cider at Loïc Raison.



Diffusor at Cidrerie Volcler.

steel or glass fibre tanks for 2 to 10 months in order to achieve the secondary malolactic conversion. The total tank capacity is 240,000 hl.

The cider is separated in a centrifuge and filtered through a kieselguhr drum filter. Oxidation does not cause any worries. 'Cidre fermier' is not filtered. For stabilisation bentonite or gelatine is applied. Finally, the cider is carbonated and 50 mg/l sulphite is added (100 mg/l to the unfiltered cider).

The cider is packaged into returnable 250, 330, 750 or 1000 ml glass bottles on a 10,000 bottles per hour (750 ml) bottling line. In another line 1,5 l non-returnable PET bottles are filled. The glass bottles are tunnel pasteurised and the cider in PET bottles are flash pasteurised at 65°C for 10 minutes (52 PU).

Loïc Raison does not put a best before date on their bottles, but they recommend to drink the cider before 9-12 months after filling.

Volcler

Cidrerie Volcler was established around 1920 and is family owned for 3 generations. The production plant

is the 3rd biggest in France with an annual production of 100,000 hl cider. Volcler is situated in the town of Mayenne in Pays de la Loire just south of Normandy.

Volcler owns 20 ha cider apple orchard and receives apples from local farmers as well – some on contract – some without. The apples are received in the court yard in front of the cider plant and stored there for a few hours (not more than 2 days). The apples are sorted, varieties are mixed and then washed with water down into gutters in the court yard. The gutters end up inside the building in a rotating drum, where stones, leaves and rotten apples fall through. The healthy apples are conveyed up to the mill. The pulp is pumped to a continuous belt press for extraction of the juice. The first juice is stored in an underground hopper. The pomace is conveyed to a diffusor, where the sugar in the pomace is washed out with water/apple juice running counter current to the pomace. The remaining pomace is dried in a drum drier and the dry pomace left is sold for recovery of pectin. 6,000 tons of apples are received a year and the apples are treated at a capacity of 10 tons/hour. 1 ton of apples yields 800 l juice.

Pectinase and sulphite are added to the juice and let stand for 1-2 days. The juice is then pumped into a continuously working flotation tank (100 hl/h), in which artificial 'défécation' is performed by adding CaCl₂ and blowing-in N₂-gas. The gas makes the Capectate formed rise to the surface. The juice is clarified in a centrifuge and/or by filtration.

The spontaneous fermentation takes place in a large 6,000 hl outdoor tank for 2 months with no possibility of controlled cooling. Alternatively, the fermentation takes place in tanks standing in a 7°C cold room for 5-6 months. If the fermentation proceeds too fast, some of the yeast is separated in a centrifuge before proceeding with the fermentation. The secondary malolactic conversion is not wanted.

The cider is clarified with albumin or bentonite in squared steel tanks. Then the cider is filtered through a kieselguhr plate and frame filter. If the cider is very hazy it is first separated in a centrifuge. The cider is blended and stored in stainless steel tanks or painted mild steel tanks at 7°C until packaging. The total storage capacity is 34,800 hl.

Before bottling carbon dioxide is adjusted. Returnable and non-returnable glass or PET bottles of 250, 750, 1000 and 1500 ml are filled. Glass and PET bottles are tunnel pasteurised at 60°C for 20 minutes.

Malic acid and sugar are not used and colour is only seldom added. High gravity cider is not made.

Volcler makes 3 types of cider: sweet, dry and extra dry. The content of residual sugar is 65, 30 and 20 g/l respectively. The corresponding alcohol content is 2, 4 and 5% v/v. All 3 types are made as 'table' and 'bouché'.

Vergers de Giverny

Vergers de Giverny produces 'cidre fermier' and is positioned close to Monets garden in Giverny in Normandy. The apples are from the farms own 8 ha orchard, of which 5 ha are cider apples. 10 different apple varieties are blended so that 10% are acidic, 20% are bitter and 70% are sweet cider apples. The apples are hand picked from the ground, when they fall off the trees.

The apples are milled and pressed in a mobile apple press. A 'cheese' is build in the English way with totally 10 layers with ca. 500 kg apples. This yields ca. 300 l juice.

Défécation is made if the temperature in the cellar is below 10°C. Normally, the process lasts for 4-5 days, but it can be necessary to add CaCl₂ and/or enzymes to initiate the process. By défécation the nitrogen content is reduced from ca. 56 mg N/l to

ca. 40 mg N/l in the juice.

The juice is fermented naturally and spontaneously for 2-3 months in stainless steel tanks (6 each 45 hl). The cider is not fermented to dryness and the residual sugar is used for production of carbon dioxide by fermentation in the bottle. This secondary fermentation lasts for 2 months and pure yeast cultures are used. The secondary malolactic conversion is claimed also to take place in the bottle.

After the main fermentation or if the fermentation proceeds too fast because of too high temperature, the cider is filtered through a kieselguhr filter with horizontal plates.

Vergers de Giverny makes 30,000 bottles (75 cl) each year of semi-dry cider with 5 % alcohol v/v and dry cider with 6 % alcohol v/v. They also make calvados, which is stored 3, 5 or 10 years in wooden barrels, and pommeau, which is stored 1½-2 years in wooden barrels.

Vergers du Val de Sée

Vergers du Val de Sée produces 'cidre fermier' and is situated in the town of Brécécy in lower Normandy. Their cider is called 'le Brécéen' and they also make apple juice and pommeau. The apples are harvested from the 22 ha orchard, of which 20% is used for cider. 16 varieties of cider apples are grown and they are hand picked from the ground during the months of September to December. The apples are stored in wooden boxes for 1-2 months in order to mature. The apples are washed manually, conveyed up to the mill mounted on a mobile unit together with the press. The press is a screw press for the traditional English 'cheese'.

Défécation lasts for 1 week to 10 days using enzymes and CaCl₂. The fermentation in glass fibre tanks is spontaneous and takes place at 12-13°C for 3-4 months. The temperature is kept constant in the room in which the fermenters are kept.

The cider is filtered through a kieselguhr filter and bottled in March to May. The cider matures in the bottle at 9-10°C for 2 months during which the remaining yeast produces carbon dioxide and sometimes the secondary malolactic conversion takes place. Acid or sulphite are not added.

225 hl cider is made each year and 70% is sold to restaurants.

30 producers of 'cidre fermier' have employed a consultant to monthly visits for tasting the cider and giving advise on the production process. The consultant also distils the finished cider to Calvados, which again can be blended and matured to pommeau.

Cider Production in Denmark?

One of the purposes of this study tour was to suggest a modus for production of cider in Danish breweries having spare capacity as a result of the stagnation in the Danish beer market. The author did not succeed in finding a brewery neither in England nor in France making both beer and cider. In England 2 breweries bottling cider were found: Aston Manor Brewery bottles cider for Knight's and Moles Brewery bottles their own brand made at Thatchers. Being asked the brewers reasons for not producing cider themselves were the risk of cross-contamination between the different types of yeast culture.

In Sweden and Finland cider has become very popular the past years and there are several breweries making cider and beer. However, the production methods in these breweries are very different from the English and French methods and it is outside the scope of this paper to go deeper into these methods. In stead I will briefly suggest a way of producing an English cider type in a Danish brewery.

The following approaches could be made:

- Reconstituted apple concentrate is used:

The existing beer production plant can be utilised with small changes. Additional yeast propagation facilities are required separate from brewers yeast handling. Storage tanks and reconstitution tanks for apple concentrate are also required.

- Apples are used directly from farmers or other suppliers:

Equipment for treatment of the apples are required: intake system and washing facilities, hammer mill, apple press and storage tanks. From fermentation and onwards the existing beer production plant could be used. Also here additional propagation facilities are required.

It could be worthwhile finding out whether it is possible to use brewers yeast in stead of wine yeast. However, this approach is considered doubtful and it also limits the strength of high gravity cider.

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