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Suffolk Traditional Orchard Group

APPLE JUICE AND JUICING

Advice Note 22 (STOGAN22)

June 2020

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HERITAGE FUND

1. INTRODUCTION

A small farm orchard - one tree of each of about 20 varieties; apples, pears, plums, cherries, and cobnuts.

In autumn 2014 it was estimated that there were at least 24 local apple day events in Suffolk that involved making apple juice and offering it to the public to drink. Four were major events, the rest comprised smaller group activity. Extended to the UK as a whole, and bearing in mind that many events occur without widespread publicity, it seems likely that over a thousand such happenings occur throughout the UK each year. Add to that the number of individuals that juice apples (and pears) outside public events with their own, borrowed or hired equipment, it becomes clear that over this short period many thousands of litres of juice are produced and consumed fresh, or are stored for later consumption. There are some safety concerns, and STOG members, having noticed the wide variety of philosophies that seem to be followed, have asked for guidance as to which practices are safe.

This Advice Note has been written using Suffolk Traditional Orchard Group members' literature searches and their widely varied experience and has been checked by food scientists and health and safety specialists. It includes suggestions on how to improve the quality and storage of homemade fruit juices. The production of cider is not included although some, but by no means all, issues are the same.

The principal concerns are health risks from animal life around where fruit trees grow, the risks from bacteria such as *E. coli*, *Salmonella* and *Penicillium* sp, and mycotoxins (for example patulin) in partly decayed and damaged fruit. In the USA, it seems that arsenic levels in apple juice are of concern, and although this appears to be of unique concern in the USA, potentially there could be a similar issue here.

In 2014 Google "juicing apples" got over 600,000 hits, in 2020 there were 1,810,000 hits. The most widely used UK websites providing advice to juicers, we believe, are Orange Pippin Fruit Trees and Vigo, the manufacturer of a large proportion of small scale pressing equipment sold in the UK (see Further Information).

However, no UK website (that we have found) or government agency addresses the risks incurred in making and drinking unprocessed, or processed, apple, pear, grape, or any other juice, although in Europe some emphasis placed on risks from mycotoxins generated by fungi on rotting fruit. By contrast, USA websites are full of both general and specific warnings from their Food and Drug Administration (FDA) (and more histrionic sources!) dealing with the risks from bacterial contamination, inorganic arsenic compounds, and to a lesser extent, from mycotoxins. As a result USA information is far more readily available and more detailed than that in the UK.

As usual, sorting the informational wheat from the chaff (or is that 'the juice from must') has not been easy.

2. PRINCIPLES OF APPLE AND PEAR JUICE PRODUCTION

Domestic juicing machines are not dealt with here. Generally they are relatively expensive, low output, electric devices that crush fruit and squeeze out the juice using a grill or mesh filter producing a glass or so at a time and need to be washed and cleaned between each use.

Juicing at this craft level consists of first reducing fruit by milling or scratting in a hand operated (or electric) scratter into small pieces called must. The term **must** refers to the broken, milled, apple pieces before they are separated from the juice. The term has been used in England for centuries and originates from the Latin term for crushed grapes, *mustum*. In Germany and Austria the term is *most*, also referring to the juice after pressing. Apples and pears selected and grown specifically for juice, cider or perry production are called **mostapfel** and **mostbirne**, equivalent to the UK terms cider apple and perry pear.

The must is then placed in an open-weave cloth bag in a press (most common is the screw hand-operated barrel press shown on page 4) that compresses it so that the juice runs out of the must leaving behind the semi-dry mass of nearly juiceless *pomace* (from the Latin *pomum* a fruit, a term that originally applied to grapes). The milled small fruit pieces of the must should not be too small as they can block the flow of the expressed juice through the cloth.

In this respect juice extraction is exactly the same as the production of apple juice for making cider.

Confusingly, in recent years pomace has also become the term used by some equipment manufacturers for the wet milled unpressed must. However, historically it was **must** before pressing, **pomace** after. Apple and pear pomace can also have a use after the pressing, see Appendix 2.

This batch process is an ancestral method although today, continuous industrial machines can carry out the entire process in one pass.

Most manufacturers of scratters and presses have excellent instructions and books, and websites galore cover designs for home-made equipment; the Further Information section contains a list of sources. In fact, quite simple equipment can be used to extract apple and pear juice. To scrat or mill, a clean wooden post about 100mm/4” square can be used to pound fruit in a metal bucket, and then the must placed in an old fashioned cullender/colander (preferable a stainless steel one) and the juice pressed out. The yield will be about half the juice extracted with a proper press.

Many people drinking fresh apple juice for the first time are truly amazed at the strength of flavour.

Others are just as impressed by the amount of physical effort that has goes into the process!

Some are uneasy at the often apparently casual and relaxed attitude to hygiene and food safety!

A few think drinking the juice is a waste when it could be made into cider (or cyder)!

3. PRACTICAL JUICING AT APPLE DAYS

In the context of a “traditional” Apple Day a typical juicing project is a **four stage process**!

Stage 1 The first team wash and cut up apples and remove the bad bits.

Stage 2. The second team crunches up the apple bits in a scratter (or in a bucket with a wooden post!). “Scratting” is the process of breaking the apple sections down to small pieces for pressing, creating “must”.

Stage 3 The third team tips the must into a cloth within the press, winds down the press and collects the juice. Then he removes the “pomace” and starts again (by now there is only one chap left!)

Stage 3

Stage 4 Then everyone comes back when the work is done to pour the juice into cups.....and drink it!

Stage 4

4. PRESERVING FRESH FRUIT JUICE

"Unprocessed" juice contains water, sugars, acids, tannins and a vast range of aromatic compounds that provide the characteristic flavours of the specific fruit, including many organic and inorganic compounds that have been transported from the root to leaves. Juice will also contain any foreign body, live and dead, or chemical that was in, or on, the skin (i.e. not washed off) or in the natural apertures of the fruit. These are the areas difficult to wash, including the stalk cavity and any open eye, where the stamens don't close off the space towards the core. Similarly foreign bodies, live and dead, or chemicals generated from bacteria or fungal infections within the fruit (at a bruise site for example, or damage from a codlin moth) will also be found in the juice. Ultimately all fruit will finally decay from internal and external breakdown caused by micro-organisms, plus its own enzymes, and produce a new set of chemical components as this occurs.

Fresh fruit juice can be "processed" to reduce risks to health - carried out in several traditional/ ancient ways and several modern ones.

FILTRATION and/or **SETTLING & DECANTING or RACKING** can be used to remove fine particles of fruit cells left in the juice. These methods reduce the density and turbidity of fresh juice, changing both the flavour and the "texture". This is not necessarily considered a benefit by some enthusiasts, who appreciate what others have sometimes called 'apple mud'!

The most ancient processing method is **COOKING,** heating to boiling point or above, which kills most living organisms (although some are surprisingly resistant), but also alters flavours by destroying some of the aromatic compounds, which characterize fresh juice. Boiling fresh apple juice is recommended by the USA Food and Drug Administration for anyone who is at risk due to "AIDS, also cancer patients, diabetics, recipients of organ transplants, and others with chronic diseases" (see http://www.foodsafety.gov/blog/apple_cider.html . (In the USA, fresh apple juice is known in most states as "cider" or "apple cider". Fermented cider is called "hard cider"). There is no such specific recommendation in the UK.

PASTEURIZATION is the process of heating liquids to 72 °C (161 °F) for 15 seconds. Less time is insufficient to kill bacteria; longer may change the fresh flavour. Not all bacteria will be killed, but their efficiency is markedly reduced. *E. coli* and *Salmonella* are of the most concern. Almost all juice sold throughout the world is pasteurized. However, this does not destroy many other chemicals, such as mycotoxins, or residual pesticides.

Fig. 1 Apple juice, frozen or pasteurized, can be used at any time of the year as a hot spiced drink (with ginger, all spice, cinnamon and lemon), or, as a chilled drink with elder flowers and lemon, as here. Fresh or frozen, quince can be left to steep (summer) or be heated (winter) to add its intense aroma.

CHEMICAL PRESERVATIVES (sometimes known as 'E numbers') can also be added (without heating) to fruit juices to kill bacteria. These include sodium sulphite, E220, E221 and sodium metabisulphite (available as Camden Tablets) and E223, which generate sulphur dioxide in water or gaseous sulphur dioxide. These kill bacteria and fungi, and also can be used to prevent infestation or re-infestation, as they are in wine making, both professional and

amateur as they also kill yeasts and stop fermentation. However they may influence taste and are difficult to judge for fresh juice. They are not recommended here.

FERMENTATION is also a form of processing, in the sense that it preserves the juice by altering sugar content to ethyl alcohol and, in the process, can kill some other micro-organisms as the alcohol content increases. Fermentation also destroys some mycotoxins, specifically patulin, so reducing or removing risks from damaged fungus infected fruit known as “brown rot”.

FREEZING (to lower than -10°C to -18°C) has become a preservation technique that also “processes” juice by killing, or at least drastically reducing, live bacteria and fungi. It become very useful for home-made juice as its doesn’t change the flavour as much as some pasteurization techniques. Many texts state that juice may be kept frozen for up to 6 months at 18°C, but this can be far exceeded without risk. However, even after a year, defrosted fresh apple juice will slowly start to ferment from the few yeast cells that were not killed.

Fig. 2. Un-pasteurized and filtered through a cloth, apple juice freezes well in plastic milk bottles. (The juice on the left is Horsford Prolific, a Norfolk apple).

The bottles (apple, Reinette du Canada) and a local mix (from the Old Post Office trees in Thrandeston, Suffolk) are juice from apples taken to a local juicing plant, then filtered more efficiently than using just a cloth, bottled and pasteurized. The bottles are returned the following year to be used for the next crop.

5.0 PRACTICAL JUICING GUIDANCE

Here are some thoughts gathered from many experienced choppers, crushers, pressers and connoisseur drinkers that may help to improve the quality of the experience and the juice, for both Apple Day events and home consumption.

1. **Plan the source of apples well in advance**. There have been many occasions when the apples have not arrived in enough quantity or quality to satisfy the demand. This has particularly been true for early apple days in September when there have not yet been significant windfalls.

2. **Taste some of the apples you plan to juice before using them**. Don’t just use whatever is brought in. If an apple isn’t ripe enough that you would eat it, the juice is unlikely to be at its best. Look at the pips; if they are white or white and brown the apple is unlikely to be ready to juice. Use dark brown to black pipped apples only. Hard, long keeping apples will produce a thin unexciting juice early in their season. Norfolk Beefing and some other bland cooking apples never juice well. Also remember that many traditional dessert apples are not ready to eat even in October and are really much better kept to juice months later, especially Sturmer, D’Arcy Spice, Winston and Idared.

3. **In September apples ready or almost ready will produce the best juice.** This includes Discovery, Worcester Pearmain, James Grieve and Ellison's Orange. The addition of early cooking apples like Grenadier and Emneth Early with a few Bramley's Seedling and Newton Wonder will add some acid. Acid flavours are important as well as sugars.

4. **October juicing, especially late in the month, can take in a much wider range of crop.** A mix of acid from cookers and sweet from desserts is best and the juice from late October has a far better aroma than earlier in the season. Mainstays at this time are Lord Derby, Lady Henniker, various Cox forms, the mid-season and early Laxton varieties, plus russets like Egremont, Golden and Brownlees that have less juice but lots of aroma and complexity.

Fig. 3 This splendid collection of local apples at an October Apple Day includes both late dessert apples best left un-juiced for eating at Christmas, a bin of very acid Bramley's Seedling, and a lot of nice red, but still very bland Newton Wonder, best cooked December onwards. Only about one third are close to their natural pick and eat state. However, a box of Cox's Orange Pippin and a roughly similar amount Bramleys Seedling would produce a well-balanced high-quality juice.

5. **Many experienced juicers say the best, most varied flavour, and most juice, are from November juicing**. Almost any apple still edible at this time can be used.

6. **Some of the most interesting flavours are from single variety juice, or discrete blends of just two complementary varieties.** Some of these should not be made until the variety is fully ripe, especially with the long keeping varieties. Single variety juice can be made from Lady Henniker, Golden Noble, Laxton Superb (in November) and Sturmer or Winston (in January). D'Arcy Spice can make a delicious juice in February. Lord Lambourne was voted best single variety juice at a recent meeting of Friends of Brogdale, but as this is ripe late Sept/early October it is a bit early for most Apple Day events. On another occasion the vote went to juice made from a "wild" hedge apples! The best blend is often said to be Cox's Orchard Pippin with Bramley's Seedling or Lord Derby.

7. **Pears, Quince and Medlars can all be added to apple in the press** (or by mixing the juices). However, be careful with quince which has a highly perfume-like flavour not appreciated in concentration by everyone.

8. **Dessert pears on their own tend make juice sweet and lacking in character.** Slightly unripe fruit is better than fully ripe. Perry is made from a mix of pear varieties that includes sweet and juicy plus higher tannin varieties that are not eaten raw and only added to provide flavour. However, two very interesting pear juices tasted this winter included

a single variety Catillac, the hard culinary pear that can be produced in quantity from large old trees, made using the frozen method (see below No 28), in January. Also the pear Merton Pride mixed with Bramley's Seedling (pears can be mixed with apples to add considerable flavour interest). Very ripe modern dessert pears (Conference, Concorde etc.) make rather bland, sweet juice and can block the mesh bags used in presses.

9. **Apple juicing equipment comes in many makes and forms.** The best designs are expensive and rugged. Some cheap versions (including copies of the best) are not well made, being unbalanced and not strong enough to withstand the pressures needed. The illustrations are of a 10L Vigo press and an associated manual scratter.

10. **Practice on the equipment you plan to use well in advance of the great day.** You may need some basic farm carpentry to make the stand for a scratter and, unlike the one in the illustrated in Stages 1 and 2 on page 4, needs to be at a suitable height for comfortable operation.

11. **You will be surprised how much water is going to be needed to wash fruit**, **equipment and sticky hands!** The team shown had three 20 litre water containers and it wasn't enough. Running water from a hose is obviously the most effective, although very wasteful.

12. **Don't forget disposable cups for sampling fruit juice**.

13. **A large heavy-duty plastic rubbish or rubble sack (or three) will be needed.** These are for the discarded parts of apples not used and the pomace. The amount of pomace produced will be roughly equivalent to a little less than the original pile of apples. Pomace can be composted, used for cooking (see Appendix 2) or fed to pigs (who think it's wonderful!).

14. **Washing apples isn't essential if they are picked straight off the trees and not stored before scratting.** If they are windfalls, washing is necessary if they have mud or soil on them. They shouldn't be used if animals have been grazing below the trees for less than 56 days (8 weeks) previously. This is not a regulation, but is a recognized period in some management schemes for cider apple.

15. **Trees that are sprayed with pesticides or fungicides should NOT be harvested for fruit juicing.** Most pesticides and fungicides genuinely permitted for fruit tree spraying are permitted a specific number of days before harvesting. However, it is best not to use fruit from known sprayed trees...just in case. In reality, sprayed fruit trees in gardens or old farm orchards are now uncommon. In East Anglia there are few commercial orchards that supply apple day juicers.

16. **Apples are most easily crushed to juicing size if cut in half**, **for small apples, and quarters for large ones**. Peeling and coring isn't necessary or beneficial, both are edible even if only a few enthusiasts eat apple cores!

17. **All brown flesh and heavy bruising of any size should be cut out.** A good rule of thumb is don't juice any parts of an apple or pear you would not eat yourself. This doesn't include the fast browning of flesh occurring due the oxidation of tannins that are an important flavour component. It does include brown bruised areas of "Brown Rot" that may contain mycotoxins produced by fungi (especially patulin and more rarely, aflatoxin).

18. **Aim to produce 1 – 1.5cm fruit pieces during the scratting process**. Sometimes this might mean putting the milled fruit through the scratter twice. This is not usually too much trouble.

19. **Don't rush the pressing process.** Surprisingly, a slow press with pauses between sessions of pressing gives a higher yield than rushing and pressing as hard and as quickly as possible.

20. **The dark colour of apple juice is due to tannins that oxidise in air as the juicing process continues.** The slower the process the darker the colour, and some varieties with high tannin (e.g. Cox and Laxton's Superb) make darker juice than low tannin apples (e.g. Lord Derby). Some people add ascorbic acid/Vitamin C at this point which does reduce further browning of juice, but is usually too late to have much effect.

21. **Strain the pressed juice to remove fragments of fruit flesh.** Muslin or wine straining mesh is sufficient to remove most large pieces of apple, but won't remove the main quantity of fine cell fragments. These particles give the juice a characteristic texture that is, for some tipplers, part of the fresh juice experience.

22. **Settling and racking is a simple process can be used to remove a large proportion of particles.** It requires large containers with a tap about 4-5cm above the container base (wine-making suppliers sell these up to 50l in size). The fresh juice is placed in the container and left on a table in a cool place overnight. This is to allow tapping off of the liquid later and reduces the amount of fermentation from live yeast. After 12 hrs or so the largest particles will have sunk to the bottom and the tap will allow the liquid above the layer to be decanted off. Do not leave longer than this as any more vigorous fermentation will stir up the particles.

23. **Wine filter papers and filter pumps can be used to filter out fine particles.** It's a very slow process, and to some extent the character, texture and taste, is then somewhat altered, so complete filtering to a clear juice is very rarely carried out. Some of the dark colour is concentrated in these tiny pulp fragments and so completely filtered juice is much paler in colour than unfiltered juice.

24. **Untreated apple and pear juice cannot be stored for long at room temperature before beginning to ferment.** Yeast cells present on, and in, the fruit start to process the sugars to alcohol almost immediately. Untreated apple juice allowed to slightly ferment to a slight "prickle" (one to five days in the fridge) can be a very pleasant, if short-lived drink. (It is a real favourite in the USA, especially traditional in many parts of New England, and is called "apple cider". Although it has a tiny alcohol content, it is often given to children. Fully fermented to cider, it is called "hard cider" in the USA.)

25. **Fresh apple and pear juice can be frozen and defrosted to drink later.** In polyethylene milk bottles they keep almost indefinitely, an ideal winter breakfast juice. The juice can also be put into polythene bags, stood inside juice cartons/tetrapacks with the tops cut off, and frozen; once frozen the brick-like shapes can be stacked and the cartons re-used. Frozen juice keeps almost indefinitely at -18°C, but is safe for a year.

26. **The alternative to freezing is pasteurizing**. This should be done at 75°C for long enough to kill the microbes (usually about 15-25 seconds, but of course that temperature needs to be maintained throughout the container so instructions always err on the generous side, risking a cooked flavour). This can be done by sitting the bottles in a large, deep saucepan of water on a stove and using a good digital thermometer. Or buy a reliable pasteurizer; some can handle plastic wine bags for storage. Some pasteurizers are very flexible with fruit juice steaming attachments etc. Juice in pasteurized glass bottles keeps for up to 2 years, but for only 6 months in plastic.

27. **Treating juices with sodium sulphites or metabisulphites is not recommended.** We have had no practical experience of the method and been given very mixed information. The technique is well documented for wine (and some cider) making which is then fermented with introduced yeast, but it is not well documented for the treatment of home-made juice.

28. **Freezing the whole fruit is a practical method that avoids the need for scratting.** This requires advanced planning with the washed and cut up fruit (skin and cores retained as before) being placed in a freezer at -18C for a few days to a week. This breaks down the cells and when removed and defrosted the fruit sections can be easily crushed and placed directly in the press. We do not have any information on any comparative tasting so the effect on the flavour of the juice is unknown, but the quality of some that we have tasted was excellent, especially of hard late culinary pears. There a number of very distinct advantages to this method:

    - No scratter is required.
    - The juice yield does appear to be slightly higher than using unfrozen fruit.
    - The juice has far less solid matter – particulates, broken cells and fine flesh particles - probably because less pressure is required. So any filtering requirement is less.
    - Much harder fruit can be juiced including culinary pears such as Catillac and late ripening apples such as D'Arcy Spice, Winston (perhaps even Norfolk Beefing, but don't expect much flavour).
    - The juicing process can be delayed into winter.
    - There is, of course, a disadvantage; it requires a large amount of freezer space.

6. RISKS TO HEALTH FROM DRINKING APPLE OR PEAR JUICE

Mycotoxins and fungal rots on fruit

Apple juice is as safe as the apple it came from. However all apples have fungal growths even straight off the trees and therefore a proportion of apples will have developed low levels of the toxin patulin in brown rot areas, which are usually bruises that have turned brown by fungal action, some so small as to be unnoticed. Patulin is toxic, but is no more frequent than in other fruit and cereal grains, shellfish, jams, processed fruit juices, even to some extent in some alcoholic drinks like cider.

In 2003 the European Union set a limit of 50 micrograms per kilogram (µg/kg) in both apple juice and cider, 25 µg/kg in solid apple products, and 10 µg/kg in any products for infants and young children. These limits came into force on 1 November 2013 and are considered to be the Tolerable Daily Intake (TDI) for patulin.

TDI refers to the daily amount of a chemical that has been assessed safe for human beings on a long-term basis (i.e. a whole lifetime). Most commercially available pasteurized apple juice averages about 10–15µg/Kg of patulin. Sulphites used as a preservative do break down patulin in juices, and patulin is also broken down during fermentation, for example, in cider. These breakdown products however may themselves cause risks and apple juice added to *some* ciders to improve flavour may also contain patulin.

For a detailed explanation of risks, effect and legislation, see the European Mycotoxins Awareness Network at http://www.mycotoxins.org/

Arsenic compounds and concerns in the USA

Of far greater concern in the USA recently, is for arsenic compounds in apple juice. Arsenic is a naturally occurring element in some soils as both organic compounds (said to have little or no effect on humans and not retained in the body) and inorganic arsenic salts and compounds which are toxic.

The salt Lead Arsenate was widely used until the 1970's in the USA against codlin moth etc. and legislation banning its use was only established in 1988. Old commercial orchard sites could have, and some still do have, residual arsenic compounds in their soils. The FDA had already set a limit of 10 parts per billion (ppb) for inorganic arsenic in apple juice, actually the same as in drinking water! The media hype and reaction, especially online has been extensive with a TV programme carrying out analyses of apple juice! The internet has a great deal on the subject, but much may be unnecessarily inflammatory. Try searching FDA, fruit juice and arsenic.

Lead arsenate spray was replaced by DDT! There is very little information about when lead arsenate ceased to be used in the UK.

Appendix 1 How Much Juice is There in an Apple?

The answer is that it all depends; on ripeness, variety, apple size, climate, year...etc. Apples yield somewhere in the range of 0.3 to 0.5 litres from 1kg. A weight ratio of 2.5:1 is a widely used estimation (2.5kgs yields 1 kg-1litre of juice approx. but this is probably for ripe fruit). In reality much less is produced from a dessert Egremont Russet; probably more from a juicy ripe Lord Derby or ripe Concorde pears. Scaling that up and in today's terms, probably on average, it requires four full supermarket carrier bags to make 4.5litres, 1gallon, of juice.

A much more difficult question is how much can a tree yield? This depends on the tree's size, age, pruning history, variety, season, climate, weather, pollination, ground cultivation, insect, fungal and bacterial pests and any treatment, and the degree of fertilization...and probably other factors too.

A very large crop from a single apple tree was recorded as being estimated at 600kg (i.e. more than half a tonne), which could have yielded 240litres (53 gallons). However, this was a large tree on a large growing rootstock of a very vigorous and productive variety.

Several tables can be found online, some having been copied again and again. We have done a very small experiment, counting the apples on some trees in the good apple year of 2014, and estimating their average weight from a sample (of 20 fruits), calculating their approximate yields in apples and juice (rounded to nearest 0.1 kg or litre), with some indications of variance due to differing juiciness of the varieties.

Age of tree, variety and root stock	No. of apples / estimated weight	Approx. yield
15 yr Lady Henniker on M25	144 apples, av 235gm.	Total 33.8kg, Juice 13.5litres
30 yr Bramley's Seedling	218 apples, av 210gm.	Total 45.8kg. Juice 18.3 litres (or more)
35 yr Cox's Orange Pippin MM106	61 apples, av 105gm.	Total 6.4kg. Juice 2.6k litres (or less)
12 yr large culinary St. Germain-type	187 pears, av 245gm	Total 45.8kg. Juice 18.3 litres (or much less)
14 yr Dr Harvey on M27 (2.1m)	16 apples, av 215gm.	Total 3.4kg. Juice 1.4 litres
17 yr old Dr Harvey on M25 (6m)	142 apples, av 187gm.	Total 26.5kg. Juice 10.6 litres

In 1810 William Forsyth, gardener to His majesty at St James, records in his *Treatise on Fruit Trees* (as a result of his new pruning technique) the production of 2,840 pears from one tree in one year (not counting, he says, the innumerable windfalls! He was clearly talking about a very large tree grafted on pear rootstock and not a modern dwarf pear tree on a quince rootstock!

The website Orange Pippin Fruit Trees (www.orangepippin.co.uk) gives some estimates of crop per tree for apples on different rootstocks (G refers to US Geneva rootstocks) and the juice yield at 2.5Kg of fruit to 1litre (assumed to be mature trees in good production):

Age of tree, variety and rootstock	**No. of apples / estimated weight**	**Approx. yield**
Dwarf tree (e.g. M9, G11 rootstock)	10-20kg (0.5 - 1 bushels)	4-8 litres
Semi-dwarf (e.g. M26, G202, G935 rootstock)	10-40kg (1 - 2 bushels)	4-16 litres
Semi-vigorous (e.g. MM106, M7, G30 rootstock):	20-50kg (1 - 2.5 bushels)	8-20 litres
Full-size (e.g. M25, B118 rootstock):	80-160kg (4 - 8 bushels)	32-64 litres

APPENDIX 2 Uses for Pomace

Pomace (*marc de pomme, apfeltrester*) originally referred to grape skins, pips and pulp left after juice extraction for wine (called *marc* in French, *trester* in German), In England, it refers to the semi-dry *apple* pulp removed from the press after juice extraction. It can of course be considered a waste in quantity, and, especially in water courses, can be a serious health hazard. In the past, it was widely discarded into hedgerows to rot down. However it is bulky, organic, still has considerable food value and has sugars, pectin and flavoured juice still un-extracted. The following are some ancient, and modern, uses for pomace.

1. In some cider traditions of the 16th to 18th C, a secondary pressing was carried out after the pomace was soaked in water overnight and fermented to produce low alcohol *ciderkin* or *water-cider* (for children!), similar to *small ale, small beer,* or *second runnings*.
2. The extraction of pectin for food preparation and industry.
3. Pomace is a good mulch and breaks down to make a useful fertilizer.
4. Pomace can be used as animal feed: pigs are especially fond of it and are not harmed by some fermentation or minor decay. Horses too are extremely fond of it although it is usually fed to them immediately after pressing. Pomace may be dried, kept and used for animal feed. In some European countries it was dried by being spread out on hay drying floors and, with sliced raw apples, in specially constructed fruit drying sheds. Today some cider pomace is made into a dry pellet animal feed.
5. Pomace has been used as an addition to bread particularly in the USA. Recipes exist for apple bread, apple crisp (a crisp apple topping on a pudding or cake), and pomace is available in the USA in frozen packets, available in apple juicing areas like the New England states for home freezing. If pomace is to be used in this way then the apple preparation before scratting should be changed to discard cores and seeds, which are not appreciated! There are some references online to apples also being peeled before scratting. (Some more information on this use in cooking would be very helpful, if anyone has it!).
6. Further bi-products are apple and pear seeds. These will partially separated out if the scratting is carried out into a box or bucket and the must then transferred into the press; a large proportion of the seeds are then left in the must container. It was these seeds that were bagged up and sold by cider (and perry) producers for the production of seedlings as rootstocks for grafting and often called “crab stock” or “wild pear”. This continued through England until well into the 20th C and to this day is still the source of ***some*** wild pear or *Pyrus communis* seedling rootstocks for grafting large tree pears. Seedlings produced from these seeds are very variable depending on their parents and their pollination, resulting in variable vigour of the grafted trees. Recently seed from a widely grown German variety of juicing pear called **Kirchensaller** has been used to produce seedling pear rootstocks for large trees because they are more uniform in vigour. **Bittenfelder** is an equivalent apple variety.
7. In the 17th, 18th and 19th C whole orchards were planted in the USA by settlers using seeds collected from cider mills, as a means of transporting apples as a crop westwards. Hence the origins of so many unique American cultivars. Look up the story of the apple **Wealthy**!

APPENDIX 3 Commercial Apple Juicing Services

Throughout England small commercial orchards that juice a proportion of their own fruit production offer a service to juice private orchard owners' apple crop, and usually pasteurize and bottle it. There appears to be at least one such service in every county; the equipment they use varies as does the range of service available. Their conditions vary too, and it is essential to understand what a service provider can and can't do, which largely depends on the equipment they have. The season is variable depending on the year and usually starts mid-August (with Discovery, Grenadier, Worcester Pearmain etc.) until mid-November, sometimes much later.

- Some require a booking by the client to ensure a slot - some don't.
- Some wash fruit before scratting - some require the grower to do that.
- Some give detailed instruction as to what they will and will not scrat and press, for example apples with white pips, and no ripe pears, or the pears must be mixed with apples and not on their own, no Norfolk Beefings, and some definitively say no windfalls, no bird pecks, no insect bites and no damage (which for some growers defeats the object of juicing, and results in them buying their own kit!). There are other providers who are more pragmatic and use the universal rough rule of thumb that if you would be prepared to eat the apple then it is ok for juicing.
- Most service providers today have far more sophisticated equipment than the amateur manual scratters and hand-screwed barrel presses, such as powered scratters, hydropresses, belt presses, powered filtration, flash pasteurizers, bottling plants, labelling units etc. – but some don't!
- Most providers prefer to pasteurize and bottle as well as press, taking 2-5 days to do the job, with the client delivering their apples and collecting the filled bottles (generally standard wine-sized 75cl glass, sometimes 25cl). Some use water bath batch pasteurizers; others have continuous flash pasteurization at the bottling stage. Most of these organizations are short of space so collection is pre-arranged when delivering the apples!
- Most will re-use bottles just supplying a new screw closure each time, as long as they are clean when returned.
- The product from a modern continuous juicing unit is cloudy but not opaque as a degree of filtering will have been done, and modern presses are more efficient in this respect than older systems. Some will add L-ascorbic acid (Vitamin C) to reduce the "discoloration" – some don't, or don't if asked (and are therefore suitable for organic production).

Prices may depend on the size of the order to some extent. In 2014, the range was from £1.60 to £2.60 a bottle (with charities often getting a small discount). Some clients sell this product at the farm gate for £2.50 – £3.50 a bottle. Labels will cost extra, approx. 5 -10p each, and depending on who makes them (some clients design, print and supply their own) and who applies them. Some pressers supply and/or attach blank labels for the client to write on. Generally the operators of large continuous machinery are near large growers, and their services tend to be cheaper than small operators in isolated areas. The prices in 2020 do not seem to be very different, but there are more online organizations providing service and prices; search for "Apple juicing services".

Appendix 4 Checklist for Apple Day Juicing Volunteers

- Plan the source of apples well in advance.
- Practice on the equipment you plan to use well in advance of the great day.
- Never accept apples from sprayed trees. Trees that are sprayed with pesticides or fungicides should NOT be harvested for fruit juicing, and should be peeled before eating.
- Ensure any grazing animals in the orchard were removed at least 8 weeks/56 days prior to collection of apples.
- Taste some of the apples before juicing them. Don't just use whatever is brought in. Don't juice apples that are unripe.
- September ripe apples will produce the best September juice. October juicing, especially late in the month, can take in a much wider range of crop and always tastes better than earlier in the season.
- Experienced juicers say the best, most varied flavour, and most juice, is from November juicing.
- Some of the most interesting flavours are from single variety juice or a blend of acid cooker and sweet dessert.
- Most pears and quince (and medlars) are best added to apples in the press (or by selectively mixing of the juices). Quince are often still too hard in September, but add a very interesting fragrance.
- Dessert pears on their own tend make sweet juice often lacking in character and the soft pulp may block bags.
- Washing apples isn't absolutely essential if they are picked straight off trees that are never sprayed, but it is essential for windfalls and sites near busy roads. And you will be surprised at how much water you will need.
- Don't forget disposable cups for sampling fruit juice.
- Don't forget a large heavy-duty plastic rubbish or rubble sack (or three) for compostable discarded fruit or fruit pieces.
- Apples are most easily crushed to juicing size if cut in half for small apples, and quarters for large ones.
- All brown flesh, heavy bruising and codlin moth damage should be cut out, but cores can be left. A good rule of thumb is don't juice any part of an apple or pear you would not eat yourself.
- Aim to produce separate fruit pieces no larger than 1 – 1.5cm after the scratting process. Some rotary scratters, and some fruits, may require a second pass to achieve that.
- Don't rush the pressing process. A slow press with some stops produces more juice than one fast press.
- Strain the pressed juice through muslin immediately after pressing to retain fragments of fruit flesh. Settling overnight and racking is a simple process that can be used to remove a large proportion of particles and lower viscosity, but creates darker juice, and has a higher risk.

- Untreated apple and pear juice cannot be stored for long at room temperature before beginning to ferment (on a warm day only 15 mins!).
- Fresh apple and pear juice can be frozen in a domestic freezer and defrosted to drink later.
- The alternative to freezing is pasteurizing. Flash pasteurizing affects taste the least. Juice held at a high temperature for too long tastes “cooked”.
- We do not recommend treating juices for drinking with sodium sulphite or metabisulphite preservatives.
- Freezing the whole apples or culinary pears for a week before pressing is a practical method that in many cases avoids the need for a scratter.

FURTHER INFORMATION

Advice on juicing apples
Orange Pippin Fruit Trees *http://www.orangepippintrees.co.uk/articles/apple-juice*

Vigo Presses *https://www.vigopresses.co.uk/AdditionalDepartments/Useful-Information/Apple-Days-Community-Juicing*

Grazing Cider Orchards
Public and private policy affecting the grazing of animals on commercial cider apple orchards in the UK, Commissioned by Heineken UK Ltd in 2010 Written by Stephen Parrett, the Bulmer Foundation, University of Worcester *http://www.archiveofciderpomology.co.uk/ArchiveReports/GrazingPolicyAndOrchards2010.pdf*

Information about arsenic
Hood, E. The apple bites back: claiming old orchards for residential development Environ Health Perspect. 2006 Aug; 114(8): A470–A476. The National Center for Biotechnology Information, USA *https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1551991/*

Information about patulin
Patulin in Apples and Apple-Based Food Products: The Burdens and the Mitigation Strategies Zhong *et al*, 2018 Published online 2018 Nov 15. doi: 10.3390/toxins10110475 *www.ncbi.nlm.nih.gov/pmc/articles/PMC6267208/*

Mycotoxins Institute of Food Science Technology Oct 2018. *https://www.ifst.org/resources/information-statements/mycotoxins*

Patulin in apple juice Defra AHDB Horticulture Apple Best Practice Guide h*ttps://apples.ahdb.org.uk/patulin-apple-juice.asp* (available to download as a pdf)

Fruit pressing equipment
Vigo Ltd, a supplier of fruit juicing and cider making equipment (there are many other companies) *https://www.vigoltd.com/*

Paul Read

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Suffolk Traditional Orchard Group: www.suffolkbis.org.uk/biodiversity/projects/stog

Orchards East: www.uea.ac.uk/orchards-east