BREWING WORKSHOP NOTES

XV AMC, Castle Mountain

> *Give strong drink unto him that is ready to perish, and wine unto those that be of heavy hearts. Let him drink, and forget his poverty, and remember his misery no more.* *Proverbs 31:6-9*

Hosted by the Routier Crack Brewing Squad, the discussion group explored some of the practical concerns with brewing beverages of an historical type. Much time was spent pontificating on the original Tudor/Stuart methods and the applicability to earlier periods, before veering wildly on to short cuts, cheats and modern workarounds.

Using equipment bodged together from household scraps and plumbing fittings, our intrepid team have made a number of ales and beers from 16th and 17th century recipes using ingredients as close to the originals as possible, and despite their best efforts, have managed to produce some passable results, which were provided as samples at the workshop.

These notes formalise the discussion and provide tips and recipes for the valiant experimenter to begin their own barley-fuelled voyage of historical discovery.

Beers and Ales

I had assumed the Elizabethan writers would include all sorts of "traditional" steps that were done because they were always done and served no purpose, so we more scientific types would be able to dispense with them. I was stunned to find there's a valid, scientific reason for every step, from activating the enzymes in the barley, breaking down the starches to sugar, sticking the proteins together so they can be more easily removed, activating the yeast and aerating the wort. They even used the same sterilising agents as us, the delivery method was just a little different.

Following the 16th century process results in the optimal temperature for each reaction, every time. The wooden vessels they used retain the temperature for much longer (up to 90 minutes are needed for some steps and many of the reactions have a window of less than 10 degrees C/K in which they'll happen) than our high-tech plastics, which need blankets and other insulation wrapped around to even come close.

GRAIN

Barley

There are two broad varieties of barley available to modern brewers, two-row and six-row. The traditional barley used in England was two-row. Six row is a sub-standard barley grown in the USA for improved yield. All barley grown in Australia is two-row.

Barley was purchased pre-malted as it involved an industrial process that didn't really suit the early modern household. There is a school of thought that early modern malts invariably were smoky from the fire used for drying, but we see from Harrison that this practice was considered poor form:

> *"…they carry it to the kiln covered with haircloth, where they give it gentle heats (after they spread it very thin abroad) till it be dry, and in the meanwhile they turn it often that it be uniformly dried. For the more it be dried (yet must it be done with soft fire), the sweeter and better the malt is and the longer it will continue.*
>
> *In some places it is dried at leisure with wood alone, or straw alone, in other with wood and straw together, but, of all, the straw-dried is the most excellent. For the wood-dried malt, when it is brewed, beside that the drink is higher of colour [darker], it doth hurt and annoy the head of*

> *him that is not used thereto, because of the smoke. Such also as use both indifferently do bark, cleave, and dry their wood in an oven, thereby to remove all moisture that should procure the fume..."*

I read Markham to agree, but others have disputed how much smoke is "very well endured".

> *"For they make a very substantial fire, and much lasting, neither are apt to much blazing, nor the smoke so sharp or violent but may be very well be endured."*

If you use dried or liquid modern malt extracts, you are simply outsourcing the mashing as well as the malting. Regardless of the source, the product is more or less the same as it has been for the past 600 years. There's a table to help you calculate how much malt extract to use for a corresponding amount of alcohol.

Wheat and oats

Harrison speaks of them separately from the malt and refers to them as "sundry grain", "wheat meal", and "oats small ground". In the proportion used by his wife, 16 parts barley malt to one part each wheat and oats, there is no chemical need for the wheat or oats to be malted as the enzymes in the fully-modified barley malt are capable of converting the starches in the small amount of unmalted grain.

Richard Arnold writing his *Customs of London* in 1503 uses proportionally less malt than Harrison, but equal proportions of wheat and oats. The quote can be found in the Oxford English Dictionary:

> *"To make 60 barrels of single beer, use 10 quarters of malt, 2 quarters of wheat, and 2 quarters of oats, with 40 pounds of hops."*

Water

Most waters in the UK are reasonably hard, with people like Harrison suggesting to use the hardest water you can find to improve the yield of the hops. So with the very soft water of the Australian East coast you really do need to do something to harden it up. This gives the beer structure and backbone in the taste, without it the beer can taste flabby - rather like a wine with insufficient acid. There is a reference in the *London and Country Brewer* (1731) to people who "live on the black sandstone" tipping chalk into the wells from which they drew their brewing water. For 18 litres of water use about 5 grams of calcium sulphate.

Generally you should use a total water to grain ratio of about 7 litres per kilo.

Hops

We use pelletised hops. Pelletised hops are simply female hop flowers compressed and packed in a nitrogen filled pouch, so keep at their peak condition. In the 16-17th c, the male flowers would also have been included,

which would have lowered the yield slightly. The oldest cultivar is East Kent Goldings, which goes back to at least 1700, although others may be more appropriate to your nominated brew. If you are adding hops, you need at least a 60 minute boil to get an optimal utilisation.

Yeast

I've had no luck in identifying an historical beer yeast strain mainly because they weren't suspected until 1680 (by the Dutch naturalist Anton van Leeuwenhoek) and isolated and identified until the 1820s. All modern beer yeasts are *Saccharomyces pastorianus* (identified 1883) or *Saccharomyces uvarum* (described 1898). The ale yeasts are the wild grape yeast, *Saccharomyces cerevisiae* (which is identified as "ancient", possibly back to 3500-4000BC). Yes, that's the same strain as baker's yeast and wine yeast.

Some commercial varieties that you may be able to find are:

Safale S-04

English ale strain, ferments strongly and leaves a very compact sediment. Fairly neutral fermentation flavour. Excellent general purpose yeast.

Safbrew T-58

Spicy and phenolic, excellent for strong Belgian style ales.

Safbrew WB-06

Newly available dried wheat yeast, ideal for Bavarian style wheat beers.

Saflager S-23

Lager strain from VLB in Berlin, can produce sulphur but this will dissipate with maturation.

Saflager W/34-70

The famous Weinstephan 34-70 strain of lager yeast, one of the most widely used strains in Europe, excellent flavour and mechanical properties. Can be a little slow to start.

Sterilising

We sterilise with a modern low residual mix (effectively lime water mentioned in *London and Country Brewer*), other acceptable methods were Sulphur Dioxide fuming (the same chemical reaction as using Sodium Metabisulphate) or scalding.

> *As Sulphur hath some use in Wine, so some do lay Brim-stone on a ragge, and by a wire let it down into the Cider-vessel and there fire it; and when the Vessel is full of the smoak the liquor speedily poured in ferments the better.*
>
> *Evelyn, Sylva*
>
> *"…tun it up into hogsheads being clean washed and scalded"*
>
> *Markham*

Technique

> *"Now for the brewing of ordinary beer, your malt being well ground and put in your mash vat, and your liquor in your lead ready to boil, you shall then by little and little with scoops or pails put the boiling liquor to the malt, and then stir it even to the bottom exceedingly well together (which is called mashing of the malt) then, the liquor swimming in the top, cover all over with more malt, and so let it stand an hour and more in the mash vat, during which space may if you please heat more liquor in your lead for your second and small drink; this done, pluck up your mashing strom, and let the first liquor run gently from the malt, either in a clean trough or other vessels prepared for the purpose…*
>
> *Then your lead being emptied put your first liquor or wort therein, and then to every quarter of malt put a pound and a half of the best hops you can get, and boil them an hour together…*
>
> *This done, put the wort through a straight sieve, which may drain the hops from it, into your cooler... Standing over the gyle vat, you shall in the bottom thereof set a great bowl of barm, and some of the first wort mixed together, that it may rise therein, and then let your wort drop or run gently into the dish with the barm which stands in gyle vat... [let it stand overnight] .. and the beer well risen, with your hand stir it about and so let it stand an hour after, and then, beating it and the barm exceedingly well together, tun it up into hogsheads being clean washed and scalded, and so let it purge."*
>
> Markham

Brewing consists of three main stages. These are: converting the starch to sugar; removing the proteins from the solution and; converting the sugar to alcohol by fermentation.

The first step is the main difference between early modern and modern brewing, in early modern brewing a technique called "mashing" was used. The malted grain is steeped in water for an hour at a high enough temperature to activate the enzymes in the barley and hold it at that temperature long enough to convert as much of the starch as possible. The temperature range is between 70 and 65 degrees C. The resulting liquid is then drawn off slowly. The process can be repeated a couple of times either to augment the first lot of sugar, or as a source of a lower sugar solution for small beers and ales.

The second step is to take the liquid (wort) from the first and boil it for 60-90 minutes, mainly to stick the proteins in the solution together in to flakes big enough to be strained out. It’s really important to get a strong vigorous boil because it helps with the hot break and hence final clarity of the finished beer. The action of a vigorous boil knocks the protein debris together into flakes large enough to be easily separated from the boiled wort. You want to see hot break forming before adding hops, typically 30 minutes.

After 30 minutes on the boil, the hops are added. Modern beers leave adding the hops to much later in the boil to avoid driving off the aromatics. The seventeenth century approach keeps the bittering and preserving agents but there wouldn't be

any of the subtle flavours from the hops left behind. The main reason for adding the hops early in the boil is that the early recipes use much less hops than we would due to the high cost in the late 16th and early 17th c. and needed the extra time to get as much out of the hops as possible.

The purposes of the boiling are:

1. to sterilise the wort
2. to isomerise (i.e. make soluble) hop oils from any hops you added to the boil,
3. to coagulate large proteins so they don't cause haze in your finished beer (this is called hot break), and
4. in the case of all-grain beers (beers primarily made from grains rather than from extract), to boil off excess water (for example, after extracting all the goodies from the grains, you've got 30L of wort, but you want to make a 23L batch).

The final part of this step is chilling. Although the hot wort appears relatively clear, once the temperature drops below 50 degrees celsius a fine mist like material will be appear and fall to the bottom of the boiler. This is more protein and we have to stop this being transferred into the fermenter. To do this the wort needs to be cooled while it is still in the boiler as quickly as possible for the following reasons:

(a) To bring the temperature down so that the yeast can be pitched before rogue bacteria can take hold.
(b) To achieve the Cold Break

The third step is more or less chucking it in a bucket and throwing in either an ale or beer yeast.

Second running

The general mashing technique used by English brewers in the Elizabethan period was *double* (or *triple*) *infusion mashing*. In this, after the first infusion as been done (as described above) and the liquor has been drained off, a second batch of hot water is added to the grains, which are again allowed to steep. The second batch of liquor is then drained off and fermented. For very potent beers or ales, a third running would be performed in the same way.

These second and third mashings are mostly useless for enzyme activity - the enzymes are mostly exhausted by the time the first mashing is over, but not all of the sugars will be collected in the first running. These second mashings serve to rinse more sugar out of the grain, as an additional sugar source for stronger beers, or for brewing weaker beers or ales for the effort.

Modern techniques you may have people recommend

Sparging

Sparging is the technique of adding additional hot water to a draining bed of grain in order to rinse more sugar out the grain. It is commonly done in modern brewing, but there is ample evidence that this is a post-period innovation. The Oxford English Dictionary lists the first use of the term *sparge*, when referring to brewing, at 1839, and then again at 1885 [OED, v. 16, p. 117].

Modiferm

This is a special enzyme which allows the yeast to ferment sugars which are not normally fermentable. It is used mostly for dry beers and those suitable for diabetics. Add to the brew 24 hours after fermentation starts.

EQUIPMENT

Improvised mash tub made from an old fermenter, the bottom of an ice cream bucket and some plastic plumbing. A length of hose is jammed in the tap for decanting without disturbing the grain bed.

Boiling the wort in a stainless stew pot.

Rapid chilling

The fermenter, I’m checking the specific gravity.

OUR EXPERIENCES

Recipes

We provided samples from three different historical recipes, one from Harrison's *Description of England* (1577) describing the process his wife used at home (a middle class townhouse in Essex), another from *The Closet of Sir Kenholm Digby, Knight Unlocked* (1644) called *Mr Webb's Ale* (really a beer), and from that second run, we inferred a Small Beer (hereafter called Mrs. Robinson's Small Beer). This last one was cross checked against the small beers in Markham's *English Housewife* to keep us honest. Interestingly, Markham's *March Ale* used the same base ingredients and method as Mrs Harrison's ale but substituted pease for the spices. The last was a Honey Ale from Markham. All recipes are in another group of document also available from this site.

Mrs Harrison's ale was a mix of malted barley, wheat and oats in a 16:1:1 ratio. As the Harrisons ground their own barley to save the payment to the miller, the amount of grain was much less than the other recipes use for the amount of water. The grain had to be mashed three times, with all three runs being used in the final ale. Hops was added to the first and third wort during the boil. This uses a top fermenting (ale) yeast. This recipe calls for small amounts of wheat flour and long pepper to be added at the end, (0.0125 of a handful and 300mg respectively) so we used the approach of cooks everywhere and did the quantities by dead reckoning. Specific gravity at the end was 1.0018.

Mr Webb's ale (really a low-hopped beer) uses three times the malted barley of Mrs Harrison. As a result, only the wort from the first run through the grain was used. The amount of hops is only slightly lower than for Mrs Harrison, but still half of what a modern recipe would use. This uses a bottom fermenting (lager) yeast.

The second wort run from the grain on Mr Webb's ale can be used small beer. This was done much the same as Mr Webb's ale with 10g hops and lager yeast.

Digby's "Small Ale for the Stone" is small ale made paradoxically from the first run through the mash. This would be an easy one for those without mash tubs to make from commercial malt extract.

All the references highlighted the importance of maintaining temperature through the whole length of the mash and starting high so it was still in the right band for the enzymes at the end. Looking back at the process, we had absolutely no

trouble getting the first mash at 70-65 degrees and probably should have used water at about 80 instead of boiling for the second and third mash, due to the amount of heat retained by the malt bed. The higher temperature probably cut the sugar yield by 10% on the last two mashes, but there wasn't much sugar left after the first mash anyway.

The Ale with Honey was made the same way, with the clover honey also being mixed with a quantity of water and gently heated to allow the contaminants to float and be skimmed off without driving off the aromatic components. We calculated the quantities based on the equations in the end of this paper, assuming honey was 100% sugar and working out the amount of sugar required per litre to get the alcohol yield we wanted.

If you use dried yeast you should rehydrate it as this will give you a much better fermentation. It's an easy technique. Use about 10 to 15 ml of tepid water per gram of dried yeast in a suitable sanitised vessel. After about 5 or so minutes swirl the cup to make sure any yeast still floating is thoroughly wetted. Generally the yeast should take 20 to 30 minutes to rehydrate and be ready for pitching.

Scaling Recipes

Unless you have an 80 gallon boiler at home, you'll have to scale the recipes to fit the equipment you have. An awareness of the units the author is using is useful to keep the recipe reasonably accurate.

Harrison (1577) uses the bushel as his primary measure of dry volume for malt and grain. The most likely is the 1558 London grain bushel, of 35.27L, Digby (1644) uses an ale hogshead (221.82L) for wet measures and peck (9.0921L) for dry[1] and Markham (1615) uses a "quarter" of eight southern, or four northern bushels (standardised by the Parliament of Scotland in 1661 and abolished by the Parliament of England in 1824 – roughly 280L). The standard ale gallon was set at a volume equivalent to 4.62L in 1454 and wasn't changed again until 1688. The ale hogshead was 48 ale gallons (221.82L) but the beer hogshead was 54 ale gallons (249.54L). Of course, one or more of them may have been using the Queen Anne gallon (6.831L).

Weights can be problematic as well. Harrison uses Troy ounces (14t oz. = 1t lb = 3.73kg), most of the others use avoirdupois ounce (16oz. = 1lb). Fortunately, the bloke at the local brew shop was able to tell us 1L of medium ground (33 micron) barley weighs near enough to 600g.

[1] Unless measuring Barley, oats or malt, in which case, 1 peck = 13 L

Recipes on the Internet often make it worse as the author uses their local units while not knowing/understanding/caring what units the original was referring to. UK Imperial (453.592g), the Troy (373.241g, abolished Jan 6, 1879), the Apothecaries (also 373.241g, abolished 1 Jan 1971) and US Customary (453.597g) pounds all vary. Mercifully, the Tower Pound (14 oz T = 1 lb T = 349.91g) has been out of use since 1528. The London pound (16 oz T = 1 lb L = 466.66g) survived a little longer.

The US volumes are quite different from the equivalent Imperial measure and can create an error of up to 20%.

You'll find most pre 1600 recipes use Troy ponds and most post use the UK Imperial, while many people reproducing these for Internet publication assume all measures are US customary weights and volumes. Often they don't know any better. The problem is that the proportions of Imperial to US weights are different to the proportions of Imperial to US volumes leading to completely different results from those originally intended. I find it better to convert all the recipes into modern, metric units before scaling it to fit my (ahem!) equipment. For Mrs Harrison's Ale, I came out with 1.25% of the original quantities. Conversely, with Digby's Small Ale for the Stones, it was 62.5%, as this was made in small batches for quick drinking while fresh.

As long as you have an idea of what you are doing, you should be able to get by working on the proportions of what they used to what you need. For example, Harrison used a ratio of 16:1:1 for his barley, wheat and oats. With his yield of 0.9 (360 gallons of ale from a start of 400 gallons) we can easily scale to modern fermenters that are typically 21-23 L. The only complication is then in calculating the quantity hops and the amount of yeast. Typically, you'd be using less than 30g of hops as they were lightly used due to expense prior to about 1720, and a packet of dry or 100ml of wet yeast.

SPIRITS

Under current Australian Federal law, it is legal to own a still of up to 5L volume. If you concentrate alcohol in any manner, whether by freezing, distillation or other method, you are required to register with the ATO. Go to www.ato.gov.au and search for the phrase "Excise licensing (alcohol)" to obtain the forms. Spirits came up in the brewing discussion as the next logical step up the alcoholic evolutionary tree from beers and ales.

The earliest documented record of distilling whisky in Scotland I could find was in 1494: "*Eight bolls of malt to Friar John Cor wherewith to make aqua vitae*"[2]. Eight bolls was enough to make nearly 1500 bottles, clearly distilling was already a well-established practice, or the good friar liked a drop or two before bed. The Irish claim a much longer heritage, but get a little hazy when pressed for details.

James IV (1488-1513) was fond of 'ardent spirits'. When the king visited Dundee in 1506, the treasury accounts record a payment to the local barber for a supply of aqua vitae for the king's pleasure. In 1505, the Guild of Surgeon Barbers in Edinburgh was granted a monopoly over the manufacture of aqua vitae - reflecting the perceived medicinal properties of the spirit as well as the medicinal talents of the barbers. Raphael Holinshead in his seminal travelogue of 1527 Chronicles of England, Scotland and Ireland extolled the value of *uisge beatha.* Elizabeth I was also said to be very fond of whisky, although we don't know what her barber's cut was.

Our interest comes from trying to infer the bases so we could try a couple of seventeenth century whisky recipes. Whisky in the Tudor/Stuart period tasted very different from the modern drink. At that time whisky was consumed very young and had a brutal, raw taste. The discovery that whisky improves and mellows if it is allowed to mature was not made until the mid eighteenth century.

We found we were looking for the rawest, most brutal firewater we could get our hands on. Cheap Vodka, Aquavit or Schnapps is probably the closest if you want to try some of these without brewing and distilling your own.

[2] Exchequer Rolls 1494–95, vol x, p. 487

MYTHS

BEERS AND ALES WERE MADE COMPLETELY DIFFERENTLY FROM NOW AND DIDN'T KEEP

Despite what is written on the Internet, early modern people used top fermentation in sealed fermenters with rudimentary air-locks and did follow with secondary, bottle fermentation (sealed with corks!) using wheat grains, raisins, honey or even cane sugar as the sugar source. Small ale was ready to drink in four to five days; strong ale should be left for at least a year in the keg (tun) and no more than two. Honey ale made at Michaelmas would be ready for drinking at Lent. Bottled beers and ales were considered "exceeding quick and pleasant" (Digby).

ALES AND BEERS DIFFER ONLY IN THAT ALES BREWED WITHOUT HOPS

Ale can be brewed with hops, and many of the existing ale recipes state that a quantity of hops should be added. The quantity specified increases in more recent recipes as hops becomes cheaper and more available. The main difference is that ale uses a top-fermenting yeast and beer a bottom fermenting yeast.

THEY ONLY HAD ALES UNTIL THE 17TH CENTURY

This one is partially right; Richard Somer was selling Flemish ale (ie. beer) in Norwich in the late 13th century. This was, however, a special case; the next record of the selling of beer was not until some hundred years later, with merchants along the eastern and southern coasts of England starting to import and sell beer in the 1370s. (Bennett, p. 79)

ALWAYS PALE IN COLOUR

There's a couple of brewing websites that claim that there was no way darker beers and ales could be brewed before the introduction of the rotary dryer to produce dark roasted malts. *The London and Country Brewer* gives several recipes for Porters and other dark brews, a good 50 years before the introduction of the device.

THEY DRANK SMALL BEER BECAUSE THE ALCOHOL STERILISED THE FOUL WATER.

Having been through the process, I suspect the reason that small beer was safer than water wasn't the disinfecting effect of the low concentration of alcohol, but the hours of boiling in preparation.

BEERS AND ALES WERE FLAT/EVERYTHING WAS STORED IN WOODEN VATS

Markham recommends bottling with "corks tied strongly". Digby suggests when bottling, to add split raisins to ales (top fermenting yeasts) and bruised wheat grains to beers (bottom fermenting yeasts) to add sparkle. We found four large split raisins in each 750ml bottle to be about right.

> *Bottleing is the next improver, and proper for Cider; some put two or three Raisns into every Bottle, which is to seek aid from the Vine. Here in Somersetcire I have seen as much as a Wal-nut of Sugar, not without cause, used for this Country-Cider.*
>
> (Evelyn*, Sylva*)

> *…put into each bottle a little piece of white Sugar, about the bigness of a Nutmeg, and this will set it into a little fermentation, and give it that brightness which otherwise it would have wanted.*
>
> (*Sir Paul Neil's Discourse of Cider,* pp. 35-6)

> *The Cider made and sold here in London in Bottles may have that windiness with it as Bottle-beer hath…*
>
> (*Of Cider,* Capt. TAYLOR pp48-50)

SERVED WARM

> *I tried some Bottles all a Summer in the bottom of a Fountain; and I prefer that way where it may be had. And 'tis somewhat strange if the Land be neither dry for a sand-house, nor fountainous for this better expedient.*
>
> *(*Evelyn*, Sylva)*

USING MALT EXTRACTS

The malt extract in a beer kit can (1.7kg) will give about 2.2 to 2.3 % alcohol in a 23 litre batch (about 23 to 25 points of specific gravity).

This rule is OK if you are doing 23 litre batches. If you want to work out how much malt to use in batches that are not 23 litres, work out exactly how much malt to use based on the total solids content of liquid malt extract (LME). Note that 1.1kg of liquid malt extract corresponds to 1kg of dried malt. I calculate the quantity as if it were liquid anyway and then divide by 1.1 to convert to dried malt extract as a specific gravity doesn't make a lot of sense for a powder.

LME is 80% solids or to use the proper term, 80 Degrees Brix.
1 Degree Brix is equal to exactly 4 points of specific gravity (1.004).
Therefore, LME has a specific gravity (SG) of 1.320 (4 * 80).

Brewers Degrees are a simplified version of a Specific Gravity reading and are expressed as follows:

SG 1.050 = 50 Brewers Degrees
SG 1.012 = 12 Brewers Degrees

Also 10 Brewers Degrees = 1.3% potential alcohol in the finished product, assuming you ferment all the sugar.

In two steps, we can calculate the quantity of malt is required to achieve a certain specific gravity in a given volume of beer.

Calculate the weight factor:

Weight Factor = SG of LME in brewers degrees ÷ Total volume of the brew in litres

Then calculate the required weight of malt required:

Weight = Required SG in brewers degrees ÷ Weight factor

A couple of examples:

We want to produce a 20 litre batch of German beer with a starting SG of 1.072. It is to be an all malt beer using only Light Liquid Malt Extract.

Weight Factor = 320 ÷ 20

= 16

Weight = 72 ÷16

= 4.5kg of liquid light malt extract

= 4.09kg of dried light malt extract

As you can see it is simply a matter of working out the weight factor and dividing that figure into the required SG.

Let's try it again on a 45 litre batch of Ale at an SG of 1.058.

Weight Factor = 320 ÷ 45

= 7.11

Weight = 58 ÷7.11

= 4.5kg of Light Malt extract

It is important to note that the total weight of malt has to be added to the brewing water to make up the required volume, for example, to make 45 litres at SG 1.058 you have to add the malt to the water to make up a total volume of 45 litres. If you add the malt to 45 litres of water the specific gravity will not be high enough.

REFERENCES

Anonymous, *The London and Country Brewer*, 1736

Bennett, J., *Ale, Beer, and Brewsters in England (Women's work in a Changing World, 1300 - 1600)*, 1996 Oxford University Press

Digbie, K, *The Closet of the eminently Learned Sir Kenelme Digbie, kt., Opened...*, 1669

Evelyn, J., *Sylva, or a Discourse of Forest-Trees, and the Propagation of Timber in His Majesties Dominions. As it was Deliver'd in the Royal Society the xvth of October, [MDCLXII]…To which is annexed Pomona; Or, An Appendix concerning Fruit-Trees in relation to CIDER; The Making, and severall wayes of Ordering it*, published by order of the Royal Society in 1664

Harrison, W., *The Description of England* (from Hollinshed's *Chronicles* published in 1577.)

Markham, G., *The English Housewife*, Best, M. ed., 1986 McGill-Queen's Press (originally published 1615, 1623, and 1631.)

Sambrook, P., *Country House Brewing in England 1500-1900*, 1996.