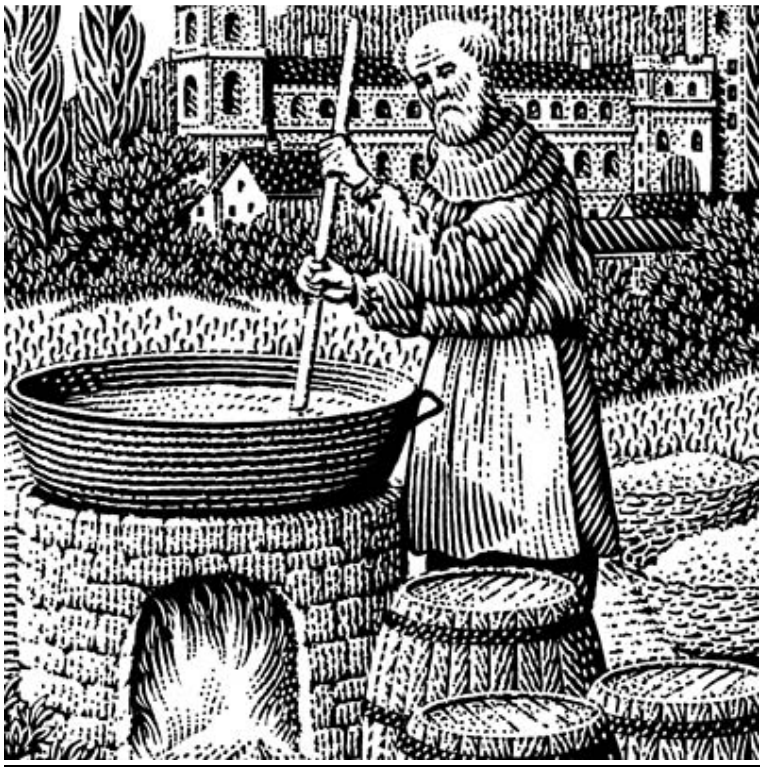
Documentation and Redaction for:

William Harrison's

Beer

As made known to us in The Description of England



By

Brother Brian Crawford

Of

Woodside Priory

Introduction:

This version of William Harrison's beer is my second attempt at this recipe. I learned a number of important lessons during the first attempt as well as conducted some additional research. The resulting recipe for this attempt is significantly different than from the first, resulting in a significantly different, and hopefully more accurate, recreation of the original beverage.

Sources:

The following recipe is drawn from The Description of England, written in 1577 by William Harrison. At the time,Harrison was serving as the household chaplain to Lord William Brooke, 10th Baron of Corbham, who as Lord Warden of the Cinque Ports was one of the most influential nobles in Kent. Harrison wrote The Description of England as the opening to a longer work, Holinshed's Chronicle, which provides a description of England in itsthen-current state before delving into its history.

I am using the version of The Description of England edited by Georges Edelenand published by Dover Publications Inc. in 1994 (second edition). In editing the manuscript,Edelenstayedfaithful to the original text with a few minor exceptions. Edelenelected to modernize some of the spelling and has glossed archaic words in square brackets [] for the sake of clarity (these will appear in some of the quotations below).

I also have access to Cindy Renfrow's version of the recipe published in A Sip Through Time. Renfrow's version does not modernize the spelling, but otherwise it is identical word for word with Edelen'sversions with two exceptions. Renfrow deletes one sentence which appears underlined below. She also does not change the original spelling of an herb "arras", whichEdeleninterprets as Orris (see the note below for more details on this change). I have elected to use Edelen'sversion because I find it more readable, and to remain consistent with quotations taken from other sections of The Description of England. I do use Renfrow's notes, as they add clarity.

I also refer to modern brewing sources for information on the brewing process, and as basis for decisions I made when interpreting the recipe.

Original Recipe:

"Nevertheless, sith I have taken occasion to speak of brewing, I will exemplify in such a proportion as I am best skilled in, because it is the usual rate for mine ownfamily, and once a month practiced by my wife and her maid servants, who proceed withal after this manner as she hath oft informed me.

{1} Having therefore ground eight bushels of good malt upon our querne, where the toll is saved,[1]she addeth unto it half a bushel of wheat meal, and so much of oats small ground, and so tempereth or mixeth them with the malt, that you cannot easily discern the one from the other, otherwise these later would clunter [clot], fall into lumps, and thereby become unprofitable. The first liquor which is a full eighty gallons according to the proportion of our furnace, she maketh boiling hot, and then poureth it softly into the malt, where it resteth (but without stirring) until her second liquor be ready to boil. This doneshe letteth her mash run till the malt be left without liquor, or at the leastwise the greater part of the moisture, which she percieveth by the stay and soft issue thereof, and by this time her second liquor in the furnace is ready to seethe, which is put also to the malt as the first wort also again into the furnace, whereunto she addeth two pounds of the best English hops, and so letteth them seethe together by the space of two hours in summer, or an hour and a half in winter, whereby it getteth an excellent color and continuance without impeachment, or any superfluous tartness. {2} But before she putteth her first wort into the furnace, or mingleth it with the hops, she taketh out a vesselful, of eight or nine gallons, which she shutteth up close, and suffereth no air to come into it till it become yellow, and this she reseveth by itself unto further use, as shallappear hereafter, calling it Brackwoort or Charwoort, and as she saith it addeth also to the color of the drink, whereby it yieldeth not unto amber or fine gold in hew unto the eye. {1} By this time alsoher second wort is let run; and the first being taken out of the furnace and placed to cool, she returneth the middle wort unto the furnace, where it is striken[laded] over, or from whence it is taken again <u>when it beginneth to boil and mashed the second time, whilst the third liquor is heated (for there are three liquors), and this last put into the furnace when the second is mashed again.</u>When she hath mashed also the last liquor (and set the second to cool by the first) she letteth it run and then seetheth it again with a pound and an half or of new hops or peradventure two pounds as she seeth cause by the goodness or baseness of the hops; and when it hath sodden [boiled] in summer two hours, and in winter an hour and a half, she striketh it also and reserveth it unto mixture with the rest when time doth serve therefor. {2}Finally when she settethher drink together she addeth to herbrackwoort or charwoorthalf an ounce of orris[2] and half a quarter of an ounce of bayberries[3]finely powdered, and then putting the same into her wortwith an handful of wheat flour, she proceedeth in such usual order as common brewing requireth. Some instead of orris and bays add so much long pepperonly, but in her opinion and my liking it is not so good as the first, {1} and hereof we make three hogsheads of good beer, such (I mean) as is meet for poor men as am I to live withal whose small maintenance (for what great thing is forty pounds a year*computiscomputandis*[taking everything into account] able to perform?) may endure no

deeper cut, the charges whereof groweth in this manner.I value my malt at ten shillings, my wood at foure shillings which I buy, my hops at twenty pence, the spice at two pence, servants' wages two shillings sixpence, with meat and drink, and the wearing of my vessel at twenty pence, so that for my twenty shillings I have ten score gallons of beer or more, notwithstanding the loss in seething. The continuance of the drink is always determined after the quantity of the hops, so that being well hopped it lasteth longer. For it feedeth upon the hop and holdeth out so long as the force of the same continueth which being extinguished the drink must be spent or else it dieth and becometh of no value."(Harrison137-138).

Notes:

The above text actually contains two recipes, one for beer and one for brackwort or charwort (note that this is distinct from braggot as no honey is used). For purposes of clarity, sections pertaining to the beer recipe are proceeded by {1} and sections pertaining to the brackwort/charwort recipe are proceeded by {2} (Renfrow 4-5)

1. Harrison notes that he is saving money by grinding his own malt rather than paying a miller to do it for him (Renfrow 4)
2. In Cindy Renfrow's version this is spelled "arras." Arras is the name of a city in France, it is unclear if the herb Orache or (as Georges Edelen indicates)Orris is being called for. Note that both are poisonous. (Renfrow5)
3. Renfrow notes that the recipe is calling for berries of bay laurel, not bayberries. (Renfrow5)

Redaction:

Ingredients:

8 bushels malt, ground

½ bushel wheat meal

½ bushel oats, ground small

3 ½ to 4 pounds best English hops

240 gallons* boiling water

Method:

Take malt, wheat meal, and oats and mix thoroughly until grains cannot be readily distinguished.

Bring 80 gallons of water to a boil and gently add to the grains in your mash tun but do not stir. Allow the first 80 gallons to sit and steep while the second 80 gallons is being heated.

When the second 80 gallons of water is at boiling, run your first wort (that is drain the grain-infused water now called "wort" from the grain). Bring the first wort to a boil and add 2 pounds of English hops. Allow them to boil together for 1 ½ hours in winter or 2 hours in summer. Once it has boiled for the prescribed length of time, set aside to cool.

While the first wort is boiling, add the second 80 gallons to the grain and allow to steep while the third 80 gallons is being heated.

When the last 80 gallons of water is at boiling, run your second wort. Do not add hops to the second wort. Bring the second wort up to boiling temperature then take off heat and set aside to cool with the first.

Add the third 80 gallons to the grain and allow to steep for the same length of time as the first and second. When this is done, run your final wort. Bring the final wort to a boil and add 1 ½ to 2 pounds of hops, depending on their quality. Allow them to boil together for 1 ½ to 2 hours depending on the season as noted above. When this done, allow to cool.

Once all three worts are cool mix them together thoroughly and ensure they are even. Once mixed, place in three hogsheads to ferment.

*note that the gallons Harrison refers to are not the same as modern gallons. See below.

Interpretation:

The above recipe, if redacted word for word, lacks a significant amount of information that a modern brewer might want, such as the type of malt and hops called for, mashing temperatures, and similar niceties. While not absolutely necessary, these details make brewing a consistent batch easier.The recipe also contains a number of idiosyncrasies that stem from the size of the batch being produced and the fact that Harrison's vessels are only large enough to handle a third of a batch at a time, something that was not uncommon. A brewer reproducing this recipe has a number of decisions to make regarding ingredients, procedures, and adjustments to scale the batch down to a manageable size for modern home brewing. I will address each of these in turn below before proceeding to the final recipe for a 5 gallon batch.

Ingredients:

Water:

I will use the ratio of water in Harrison's recipe to the quantity in our scaled-down batch to determine of the quantity of all the other ingredients I will need. Harrison calls for 240 gallons of water, but the gallon that Harrison is using is not directly equivalent to our modern gallon. Harrison defines a gallon as 8 troy pounds (Harrison 458). He doesn't specify 8 troy pounds of which liquid, but for my purposes I am going to assume that it was water and move forward, otherwise I would be here all day attempting to sort through period weights and measures instead of actually brewing. This means that Harrisons gallon was about 80% of the volume of a modern US gallon (which is approximately 8 modern pounds). When I convert this over to modern gallons I get 190 gallons (see Appendix A for the actual calculations for this and all subsequent conversions related to ingredients).

While I do not know the specifics of the water available to Harrison for his own brewing, he addresses the topic of brewing water generally in a paragraph immediately followingthe recipe. He writes:

"In this trade also our brewers observe very diligently the nature of the water which they daily occupy, and soil through which it passeth, for all waters are not of like goodness, sith the fattest standing water is always the best; for although the waters that run by chalk or cledgy [clayey] soils be good, and next unto the Thames water, which is the most excellent, yet the water that standeth in either of these is the best for us that dwell in the country, as the sun lieth longest and fattest fish is bred. But of all other the fenny and moorish is the worst and the clearest spring water next unto it (Harison138-139).

On page 138, Georges Edelenglosses "fattest" to mean hardest, or highest in mineral content. So Harrison indicates that the best brewing water is clean (not from fens or bogs), hard water. I have used Newport News city water for my brewing as it is clean and lacks any off smells and tastes. It is also high in mineral content (Newport News Water Works reports 70 parts per million of hardness causing particles in the water) and so is suitable for brewing this recipe.

Grain

Interpreting the grain bill (the total amount of grain called for in the recipe) has two main challenges: how much of each grain to use and, in the case of the malt, what variety to use.

The grain measurements are given in dry weight bushels, which Harrison defines as 64 troy pounds (Harrison459). However, to be able to use it for my purposes I need to convert it to modern American pound measurement. Fortunately troy pounds have not changed significantly

since Harrison's day. A troy pound is roughly equivalent to 0.82 modern U.S. pounds (hereafter just "pounds"). So Harrison's original grain bill converts to 421pounds of malt, 26 pounds of wheat, and 26 pounds of oats. Converting this down to8 gallons of water (to yield a batch size of approx. 5 gallons after a 90 minute boil),my grain bill becomes 17.75 pounds malt, 1pound wheat, and 1 pound of oats. (see Appendix A for conversion).

However as I discovered in my first attempt at this recipe, 17.75 pounds of grain is a massive grain bill for a five gallon batch. In attempting to sort this out I consulted with the brewers at Colonial Williamsburg, who have run into the same issue in recreating 18th century beers. Their answer was surprisingly simple. The quality of grain has not stopped improving since the recipes were written, and modern grain has around twice the fermentable sugars as historic variants. To address this they simply cut their grain bills in half. I elected to do the same, giving me a grain bill of 9 pounds of malt and a half pound each of wheat and oats.

While the call for oats and wheat meal is fairly straightforward, malt both in Harrison's time and today comes in a wide range of varieties, so determining what Harrison is actually calling for requires some furtherresearch. Fortunately, elsewhere in The Description of England, Harrison describes malt and the malting process in detail.

The key to understanding the malting process for the purposes of this recipe comes from Harrison's description of how the malt is dried. Harrison writes:

"When it hath gone, or be turned, so long upon the floor, they carry it to a kill [kiln] covered with hair cloth, where they give it gentle heats (after they have spread it very thin abroad) till it be dry, and in the meanwhile they turn it often, that it may be uniformly dried. For the more it be dried (yet must be done with soft fire), the sweeter and better the malt is and the longer it will continue …" (136).

A few sentences later (after describing how the malt will spoil if not properly dried) he continues:

"The best malt is tried by the hardness and the color, for if it look fresh, with a yellow hue, and thereto will write like a piece of chalk after you have bitten a kernel in sunder in the midst, then you may assure yourself that it is dried down. 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 most excellent. For the wood dried malt, when it is brewed, beside that the drink is higher in color, it doth hurt the head of him that is not used thereto, because of the smoke." (Harrison136).

Harrison also gives a further clue to the nature of the malt when he provides a description of the finished beer:

"Howbeit, as the beer well sodden in the brewing, and stale, is clear and well colored as muscatel or malvasia [malmsey], or rather, yellow as the gold noble, as our potknights call it…" (139).

Taken together I can deduce that Harrison's ideal malt is lightly dried and golden in color and will produce a beer that is likewise golden in color, clear, and lacking in smoky notes. There are a number of modern malts available that can potentially fill the bill, including pale two row malt, pale six row malt, American pale ale malt, and Marris-Otter malt. I have elected to use Marris-Otter malt because it is considered traditional British malt and also because I like the flavor profile it adds to the beer.

The grain bill for my version is 9 poundsMarris-Otter malt, 1/2pound wheat meal, and 1/2 pound ground oats.

Hops:

As with the grain bill,I need to determine what variety of hop to select and how much to use.

In period,brewers would have had access to whole leaf hops.However,I will be using pelletized hops because they are more readily available. While the difference in surface area between pellets and whole hops can have an effect on boil times, for boils longer than 30 minutes the difference is negligible (Garetz 159). Given the long boils in this recipe, I can substitute pellet hops for whole hops in proportions of one to one. The 240 gallon recipe calls for between 3 ½ and 4 pounds. In this case it seems likely that Harrison is calling for avoirdupois pounds rather than troy pounds. Harrison writes:

"Hitherto I have spoken of small weights; now let us see what they be that are of the greater sort, but first of such as are in use in England, reckoning not after troy weight but after avoirdupois, whose pound hath 16 ounces, as I have said before." (457).

The avoirdupois pound is not significantly different from a modern pound. Converting this down for my 8 gallon starting batch volume this becomes 2.35 to 2.69 ounces. Since at this scale the difference is so small, I elected to split the difference and use 2.5 ounces. (see Appendix A for conversion)

Harrison calls for "the best English hops" which helps me narrow down my choice of varieties. Hops were introduced to Kent in the 1400s by Flemish immigrant farmers and have been grown there ever since (Oliver316)In focusing on English hops, the most obviousmodern candidate is East Kent Golding. East Kent Golding is a family of hops known to have been crossbred from local hops by Mr. Golding circa1800 in Eastern Kent,the region where Harrison was living at the time of writing(Garetz56).East Kent Golding as a modern variety did not appear commercially until circa 1900 (Oliver316) While I cannot know for sure how different the modern version is from the local hops Harrison used, it stands the best chance to at least be similar. It also has a pleasant flavor and so I have elected to use it for this recipe.

This gives me a total hop bill of 2.5 ounces of pelletized East Kent Golding, all added at the start of the boil.

Yeast:

Yeast was not known to be the agent that led to fermentation during Harrison's day, so there is no mention made of it. This leaves me with a somewhat free hand in selecting varieties. I selected White Labs English Ale Yeast (WLP002),as this seemed most thematically appropriate and lends a full body with residual sweetness that I enjoy.

Methods:

Mashing:

To interpret Harrison's mashing process,I need to make three decisions: what mashing technique to use, what the mash temperature should be, and how long to let the mash steep.

Harrison describes three single infusion mashes. A single infusion mash is when the brewer adds hot water to the grain at a set temperature and allows it to stand and steep for a set amount of time without otherwise altering it. Harrison then drains off the infused water (now called "wort") and repeats the process with fresh water two more times. He does it this waymainly because his vessels can only hold one third of his batch at a time, forcing him to break up the process. Though it is unclear whether Harrison considers this, the multiple mashes have the secondaryeffect of getting the maximum amount of fermentable sugars out of the grain. Unlike other brewers of his time, who often brewed the three runnings(the wort drawn off from the grain) separately to create beers of varying strengths, Harrison directs the brewer to "reserveth it unto mixture", that is, mix all three runnings together before fermentation. Since at my scale I have large enough vessels to run a full size batch all at once, my main focus should be on gathering as much fermentable sugar as possible from mashing in order to stay faithful to the recipe. At my 5-gallon scale, this can readily be accomplished through sparging, that is, rinsing the grain with hot water to ensure that all of the fermentable sugars are gathered. I elected to use a sparging technique called fly sparging, in which hot water is added to the top of the grain while the wort (infused water) is drawn off the bottom, creating a continuous flow over the grain. I choose this technique as it is both easy and effective.

The next vital question is the mashing temperature. Harrison adds water at or near boiling to his grain to begin the mash. However, simply copying this directly creates problems on a 5-gallon scale. I know from modern brewing chemistry that an effective mashing temperature is between 150 and 155 degrees Fahrenheit. This is a compromise temperature that will allow both alpha amalyse and beta amalyse to convert starches to sugars (Palmer 141-142). If I were to add boiling water (approx. 212 degrees) to my grain bill of 10 pounds, the mash

temperature would be approximately 190 degrees, too hot for either enzyme to work properly, leaving me with an unfermentablewort. (see Appendix B for temperature calculations)When I compensate for the volume of mash and the ratio of grain to water in Harrison's recipe, adding water at 212 degrees yields a mash temperature of about 172 degrees. This is closer, but still too hot.It seems likely to me that the remaining loss of about 15 to 20 degrees can be accounted for as Harrison's vessels were probably not as well insulated as my modern mash tun (made from an Igloo cooler). Harrison also doesn't indicate that he covers the mash tun, so this may also explain the heat loss.In any case, for this recipe I will use a mash temperature of 150 to 155 degrees as this is the most effective.

Lastly, we need to determine themash duration. The length of time Harrison indicates, the time it took his furnace to bring80 gallons of water to a boil, is difficult to determine. Since I don't know how big his furnace was and what his vessels were made of,I don't have sufficient information for an accurate calculation. I do know from modern brewing chemistry that maximum starch conversation occurs over approximately 60 minutes depending on a number of factors including pH, temperature, and ratio of water to grain (Palmer141)For this recipe I will let the mash rest for 60 minutes.

Putting it all together,I will use a single infusion mash at 150 to 155 degrees for 60 minutes, followed by fly sparging.

The Boil:

The length of the boil that Harrison calls for is somewhat puzzling. He directs the brewer to "letteth them seethe together by the space of two hours in summer, or an hour and a half in winter." Why the boiling time would change according to the seasons is a bit of a mystery, though he provides a clue, stating "whereby it getteth an excellent color and continuance without impeachment, or any superfluous tartness." What this seems to suggest is that it needs to be boiled long enough to reduce the "tartness" of the hops. Since hops are harvested in the summer, it is likely that his summer hops were fresher and more flavorful than those available in winter, leading Harrison to believe a longer boil would be required. Modern brewing chemistry suggests that a two hour boil may have been superfluous. During the boiling process, the alpha acids responsible for hops bitterness are isomerized. The majority of this isomerization takes place in the first 45 minutes of the boil, with a gain of around 5% from 45 minutes to 90 minutes. At times over 90 minutes the additional return is less than 1% (Garetz 152-153). For my purposes I selected a boil length of 90 minutes to help stay true to the original recipe without wasting additional time for minimal gains.

Fermentation:

Harrison could not address fermentation in any meaningful way, but it can be assumed that it took place in the hogsheads he is using for storage, since he doesn't direct the brewer to place it in any other vessels or make any other changes before the beer will be ready to drink. There is some question as to whether these barrels, which were likely made of oak, had any impact on the flavor of the beer.In his book Pale Ales, Terry Foster writes:

"The first question is whether there were any flavors derived from the oak used to make casks. This seems highly unlikely. English oak was often used for casks and it is very dense and impervious to liquids, thus making it perfect for beer storage." (51).

Harrison indicates that he does not consider his beer fit for consumption until a month has passed since it had been brewed. Harrison writes:

"But for the household it is usually not under a month's age, each one coveting to have the same stale as he may, so that it be not sour, and his bread new as is possible, that it be not hot." (131).

According to the American Heritage Dictionary online,"stale" derives from the Middle English "settled, clear (used of beer or wine)"This "staleness" indicates that the beer had finished fermenting and that the yeast had settled out. A month's time is also fairly consistent with modern brewing times for completing primary fermentation, secondary fermentation, and conditioning. I have elected to use the standard two stage fermentation common for modern brewers. The beer spent one week in a plastic primary fermenter bucket and was transferred to a glass carboy for secondary fermentation of an additional week. This was followed by two weeks bottle conditioning discussed below.

Bottling:

Since I did not have any casks available, and casking likely did not have a significant impact on the flavor of Harrison's beer, I elected to bottle my version in standard brown glass beer bottles with crown caps. I chose this as the most effective means I have available to preserve the beer's freshness. It is unclear as to whether Harrison's beer would have been carbonated, and to what extent. As Terry Foster discusses at some length, traditional "real ales" from at least the 1800's on were placed into a cask and would undergo a secondary fermentation there. They would then be dispensed by gravity or a mechanical means. Because of the secondary fermentation they would be lightly carbonated (not nearly as much as modern beers) (Foster73-75). A similar process could have easily taken place in Harrison's casks. Since I find carbonated beer more pleasant to drink, I have elected to bottle condition my version using priming sugar. I have chosen to do this to be able to more readily compare this iteration of Lord Harrison's Beer to a previous version made with malt extract that was also carbonated.

My FinalRecipe:

Ingredients:

9 pounds Marris-Otter malt

1/2pound wheat meal

1/2 pound ground oats

2.5 ounces East Kent Golding hops

White Labs English Ale Yeast (WLP002)

5oz Priming Sugar

Water

Procedure:

1. Heat 13quarts of clean water to between 165 and 170 degrees Fahrenheit. Combine water with grains in the mash tun, mix well. Target Mash temperature is between 150 and 155 degrees. Cover and allow to stand for 60 minutes.
2. While mash is steeping, heat 20 quarts of clean water for sparging to between 170 and 180 degrees and place in the lautertun until ready to use. Target sparge water temperature is between 165 and 170 degrees.
3. After mash has rested for 60 minutes, open the valve on the mash tun and, using two vessels recirculate the wort until it runs clear. Once it runs clear allow wort to begin to drain into brew kettle.
4. When wort sits approximately one inch above the grain bed, begin to gently sparge the mash, maintaining a 1 inch layer of liquid above the grain bed while the wort continues to drain into the kettle. Continue to sparge until you have collected 7.5 to 8 gallons of wort.
5. Bring the wort to a rolling boil and add all of the hops. Do not allow the wort to boil over. Boil the wort for 90 minutes.
6. Once the boil has been completed, cool the wort to pitching temperature of between 65 and 70 degrees (I use an immersion wort chiller to speed this process).
7. Transfer to the sanitized primary fermenter and pitch the yeast. Stir vigorously to aerate.
8. Seal fermenter with an airlock and allow to ferment at 65 to 70 degrees for one week.

9. After the first week's fermentation, siphon the beer off of the trub and gently transfer to a sanitizedglass carboy. Seal with an airlock and allow to ferment for an additional week.
10. When fermentation is complete siphon the beer off of the trub into a sanitized bottling bucket.
11. If you wish for carbonated beer, prepare the priming sugar by dissolving it in 2 cups hot water and mix thoroughly into the beer before bottling.
12. Bottle the beer in brown glass bottles with crown caps. If you will be bottle conditioning, allow to stand at 65 to 70 degrees for an additional two weeks to carbonate.
13. Chill and enjoy.

Results:

Overall I am very pleased with the results of this particular recipe.

The initial mash in temperature was 152 degrees F and the final temperature at the mash out was 149 degrees F. This means the temperature was in the ideal range throughout the mash, resulting in a very efficient conversion. I had an initial wort yield of 6.75 gallons

At the end of the boil the Original Gravity for the wort was 1.060. After fermentation was completed the Final Gravity was 1.010, yielding an ABV of 6.56%.

Based on the gravity, ABV, and general body of the beer, it is easy to see how this could have been the beverage intended for daily consumption by Harrison's household.

Appearance:

The beer achieved a lovely bright golden color, very consistent with Harrison's description; "yellow as the gold noble." Based on a visual estimate I would place it between 2 and 4 SRM. The beer is crystal clear with a full white head, though head retention is not high.

Aroma:

The aroma is mostly of malt with a few earthy notes. There is virtually no hop aroma, which is not surprising given the length of the boil

Balance and Body:

The body is very light and easy to drink. The carbonation is relatively low. While malt is a strong component of the flavor, it is well balanced by a distinct hop bitterness.

Flavor:

The flavor is a pleasant mix of sweet roasted malt character typical of Marris-Otter malt balanced by a distinct hop bitterness. The hop bitterness seems to linger in the mouth, but not in an unpleasant way.

Overall Impression:

Overall the beer is a very smooth, easing drinking beer with a pleasant flavor. It is easy to see how this could be a beer intended to be drunk on a regular basis as primary means of quenching thirst. This recipe will definitely become a regular part of my brewing repertoire.

Sources:

Foster, Terry. *Pale Ale: History, Brewing Techniques, Recipes 2nd Edition.* Boulder, CO: Brewers Publications, 1999. Print

Garetz, Mark. *Using Hops: The Complete Guide to Hops for the Craft Brewer.* Danville, CA: Hoptech, 1994. Print.

Garrett, Oliver. *The Oxford Companion to Beer.* New York, NY: Oxford University Press, 2012. Print.

Harrison, William. *The Description of England: The Classical Contemporary Account of Tudor Social Life.* New York, NY: Dover Publications Inc, 1994. Print.

Palmer, John. *How to Brew: Everything You Need to Know to Brew Beer Right the First Time.* Boulder, CO: Brewers Publications, 2006. Print

Renfrow, Cindy. *A sip Through Time: A Collection of Old Brewing Recipes.* Self Published, 1994. Print.

AppendixA: Calculations for Ingredients

Converting Harrison's Gallons to Modern Gallons:

240 Harrison gal. x 8 troy pounds per gallon = 1920 troy pounds

1920 troy pounds = 1579.9 pounds

(online converter used, available at http://www.metric-conversions.org/weight/troy-pounds-to-pounds.htm)

1579.9 pounds / 8.34 pounds per gallon = 189.43

Rounded to 190 gallons for convenience

Converting Harrison's Grain Bill to Modern Pounds:

8 bushels malt x 64 troy pounds per bushel = 512 troy pounds malt

512 troy pounds malt = 421.3lbs malt

½ bushel wheat x 64 troy pounds per bushel = 32 troy pounds wheat

32 troy pounds wheat = 26.33lbs wheat

½ bushel oats x 64 troy pounds per bushel = 32 troy pounds oats

32 troy pounds oats = 26.33lbs oats

Total Grain bill = 421.3lbs malt, 26.33lbs wheat, 26.33lbs oats

Appendix A continued:

Scaling Harrison's Grain Bill to Five Gallon Batch:

8 gallons starting water / 190 gallons starting water = X / 421.3lbs malt

0.042 = X / 421.3lbs malt

X = 17.73lbs malt

Rounded to 17.75 lbs. malt for convenience

8 gallons starting water / 190 gallons starting water = X / 26.33lbs wheat

0.042 = X / 26.33lbs wheat

X = 1.1lbs wheat

Rounded to 1lb wheat for convenience

8 gallons starting water / 190 gallons starting water = X / 26.33lbs oats

0.042 = X / 26.33lbs oats

X = 1.1lbs oats

Rounded to 1lb oats for convenience

Total Grain bill = 17.75lbs malt, 1lb wheat, 1lb oats

Appendix A continued:

Scaling Harrison's Hop Bill to Five Gallon Batch:

8 gallons starting water / 190 gallons starting water = X / 3.5lbs hops

0.042 = X / 3.5lbs hops

X = 0.147lbs hops = 2.352 oz. hops

8 gallons starting water / 190 gallons starting water = X / 4lbs hops

0.042 = X / 4lbs hops

X = 0.168lbs hops = 2.688 oz hops

(2.352oz hops + 2.688 oz hops)/2 = 2.52 oz hops

Rounded to 2.5 oz hops for convenience.

Appendix B: Mash Temperature Calculations

The simplified formula for calculating mash temperature given by John Palmer in How to Brew is:

$T_w = (.2 / r)(T_2 - T_1) + T_2$

T_w is actual temperature of the infusion water

r is the ratio of water to grain in quarts per pound

T_1 is the initial temperature of the grain (in both cases I assume a temperature of 65 degrees)

T_2 is the target temperature of the mash

For my mashing I use a ratio of 1.25 quarts per pound as I find this works best. Harrisons ratio when converted to modern units is 0.53 quarts per pound.

So for calculating the Tw for my 5 gallon batch the math is as follows:

$T_w = (.2/1.25)(155-65)+155$

$T_w = (.16)(90)+155$

$T_w = 14.4+155$

$T_w = 169.4$ (rounded to 170 for convenience)

Appendix B continued:

In calculating what the final temperature with an infusion water temperature of approx. 212 degrees I had to work backwards through some trial and error to reach the temperatures of 190 degrees for my mash and 172 degrees for Harrisons. Those Calculations are listed below.

My Mash temp with 212 degree infusion water:

$T_w = (.2/1.25)(190-65)+190$

$T_w = (.16)(125)+190$

$T_w = 20+190$

$T_w = 210$

Harrison's Mash temp with 212 degree infusion water:

$T_w = (.2/0.53)(172-65)+172$

$T_w = (.38)(107)+172$

$T_w = 40.66+172$

$T_w = 212.66$