# ALL GRAIN BREWING

There is definitely an appreciable difference between the final product of extract and all grain brewing, and I feel (to avoid picking on extract brewers) it is best described as *fresher*. Rather than using a syrup based or powdered extract as your sugar source, that has been through processing and transportation, you are creating the sugar source by utilizing a grain blend of your choosing, then fermenting those sugars the same day. Also, rather than being limited by too few types of malt extracts as your base sugar source, you are given many options in regards to different grains you can use to create your beer's profile therefore having a more unique flavour outcome. It's really neat what you can do to make your all grain brew creative. The need for additional equipment does arise as a startup cost for all grain, but the ingredients are much cheaper than in extract brewing (grains vs. malt extracts). Sanitation in regards to the new equipment you will employ during all grain processes requires less attention...in a sense. Everything pre-boil is known as your "hot-side" while everything post-boil is known as your "cool side". Hot side activities *(mashing, sparging; below)* are all making their way to be boiled and thus sterilized, but still require attention to clean, soil free equipment. As soon as your boil ends, your cool side begins and sanitation, as always, must be taken into the utmost consideration.

Soaking malted grains in water at the proper temperature range, and keeping it there, will yield a conversion of the grain's starch into fermentable and non-fermentable (flavouring) sugars. These sugars are then strained and rinsed from the grains, collected in your brewpot, and you have your ***wort*** *(unfermented beer)*. In all grain brewing you (ideally) boil down to your target batch volume rather than making any concentration you wish before a planned dilution/top up as in extract brewing. Technically, you could concentrate and then dilute, but all grain processes are intended to bring you, in your kettle, to slightly more than your batch volume *preboil* without leaving any sugars behind. With this in mind, a large volume kettle is needed, capable of holding more than your target batch volume and have head space for boil activity. Additional heating and cooling is also recommended to keep things flowing smooth on your brewday. A propane/gas outdoor burner and an immersion coil or plate wort chiller should be employed where the stovetop and ice bath just won't cut it.

The process of soaking the grains in hot water is known as **Mashing**, and the process of rinsing the grains after mashing is known as **Sparging**. These two processes will be discussed as well as additional equipment needed, keeping instructions thorough and simple as possible to provide a smooth transition into all-grain brewing.

## MASHING

Grains like barley have natural enzymes, and once these grains are malted, these enzymes are ready to go to work converting. The process of malting consists of soaking raw grains from the harvest so they germinate (sprout). The grains are then kilned or roasted to different degrees depending on the type of grain used and target final product. Some grains, like Roasted Barley, are roasted as a raw grain and not germinated. I am not a maltster, and have yet to malt my own grain, so I will leave it at that.

**Mashing** is simply soaking grains (milled; see below) in water within a specific temperature range to provide the ideal conditions for the enzyme-rich barley malt to convert its starches into sugars. A grain's ability to convert starch into sugar is known as it's ***diastatic power***. Unmalted grains do not have diastatic power. *Adjunct* grains (*alternatives to barley*) such as wheat, rye, corn, rice and oats, will still provide convertable starch, but if they are not malted they need to be used alongside malted grains, or with added enzymes, for conversion. The starch does take time to convert, and for efficient starch conversion you want to mash for **at least one hour.** There are a few different methods of mashing (infusion, step, decoction) but the one I will describe here is a **single infusion** mash. It's simple. You add the grains to hot water, stir well to break up any clumps *(douhgballs)*, make sure the grains are thoroughly dispersed, and let them soak.

**Your grains must be milled (ground) before you mash**. You want to break the outer shell (*husk*) of the grain kernel to expose the starchy interior, or the enzymes won't have proper access to what they need to convert. A **grain mill** is a tool you can purchase, but they can be expensive. Your local homebrew shop should definitely have a grain mill and be able to mill grain for you at the proper crush setting. Grains in flaked form need no milling. Regardless of your grain bill (*grist*), flaked and adjunct grains aren't usually recommended for more than 50%. When using higher quanities of these grains, I would recommend adding rice hulls in the quantity 2-5% of your grist, by weight. Adjunct and flaked grains contain no husk as barley does naturally. During mashing the grains create a natural filter bed due to these husks, allowing for efficient drainage while sparging. Too much huskless material will create what's called a **stuck runoff** during sparging, and rice hulls aid in the prevention of this.

The water the grain is added to is known as your **Strike Water.** Temperature and volume of this water is important to provide the most suitable conditions for healthy and efficient enzyme activity. Temperature is more critical, volume is more loose. Here are some recommended specs in regards to mashing.

<u>Recommend Mash Temperature Range (Once grain is added)</u>

***63C-71C (145F-160F)***

<u>Recommended Strike Water Temperature</u>

***Approx. 6C (10F) hotter than target mash temperature***

Temperature will drop once grain is added, can vary depending on grain temperature and surroudings.

<u>Recommended Strike Water Volume (Minimum)</u>

***2L per kg (1L per lb) of total grist***

This minimum will provide enough water to evenly soak and submerge the grain. More is okay.

<u>Recommended Mash Length (Minimum)</u>

***1 Hour***

**Temperature** plays an extreme role in mashing and all grain brewing in general, and **an accurate thermometer is necessary at this level**. You can check a thermometer's accuracy (*calibrate it)* by placing the thermometer in boiling water and if the dial reads 100*C (212*F) then you know it is calibrated correctly. Alternatively, you can use a glass of heavily iced water, and correct calibration will be 0*C (32*F). There should be small nut on the back of dial thermometers for adjustments if needed. For other thermometers, just note the difference and adjust accordingly later when taking temperatures if you must.

Mashing at different temperatures within the recommended range will create different outcomes in the final beer, even degrees apart. Mashing at the lower end will achieve a drier beer, while mashing at the higher end will achieve a fuller bodied beer. This is due to the different chains of sugars produced that are more or less fermentable by a standard brewer's yeast.

With temperature comes time. The length of time you mash for is an important variable (*recommended time above*), and the temperature must be held as closely to your target as possible for the length of your mash. Your mashing vessel (***mash tun***) can dictate how efficient you are able to do this. Picnic coolers are very popular at the homebrew level. The insulated body helps keep a constant temperature for an hour or more without any monitoring, and the cost is low as well. A kettle can also be used as a mashing vessel, but without the integration of more costly additions such as a pump for recirculation and/or heat exchange setup (HERMS,RIMS), constant monitoring and precise heating/cooling control will be required to keep your temperature stable. If you decide to employ pumps on the hot side, keep in mind the temperature tolerance of that pump and if it has been designed for food grade use.

Whatever you decide to use as a mash tun, your vessel must be equipped with a **false bottom**, drainage spigot and tubing. Commonly a fine mesh stainless steel screen or slotted/drilled stainless steel plate is used along with standard ball valve and potential pickup tube for drainage. While stainless is commonly preferred, brass, copper and plastic are available options too. Keep food grade in mind. The apparatus can vary in style and preference, but the main function necessary is to be able to separate the sweet sugary wort from the mashed grain.

## SPARGING

Once mashing is done, you are going to strain the sugary liquid out of the mash tun and into your brew kettle. Straining alone won't get all of the sugars, and will leave you with less volume of liquid than desired. **Sparging** is the process of rinsing the grains after mashing and bringing your batch size up to slightly more than your target final batch volume. The water used to sparge is referred to as **Hot Liqour** or simply **Sparge Water**. Temperature and volume of this water are important factors just as in mashing. Here are some recommended specs. in regards to sparging.

<u>Recommended Sparge Water Temperature</u>

***77C (170F)***

Sugars flow best at this high temperature. A degree or two on either side is okay.

<u>Recommended Sparge Water Volume</u>

***Your Target Batch Volume***

When used with the recommended strike water minimum volume ratio (**2L per kg, 1L per lb**),
you will end up with enough wort in your kettle to compensate for boil off.

**Ex: 5kg** (11lb) of grist in a **19L** (5 US gallon) batch.
Use **10-11L** of water for **strike**, and **19L** water for **sparge**.
End up with roughly **23-25L** in your boil kettle (6-6.5 US Gal.)

<u>Recommended Length of Sparge</u>

***<u>30-60 mins</u>***

You don't want to rush this, or you will risk leaving too much sugar behind.

Before beginning sparging, you want to do what is called a *vorlauf w*hen using coolers to achieve clear wort, as initially small solid particles will make their way through the false bottom. (Any sort of recirculating mash system will provide clear enough wort to begin draining right away). With all hot side transfers, use tubing attached to your drainage valve(s) to keep liquid transfer smooth and free from aeration. Open the ball valve on the bottom of the mash tun about halfway, and begin to slowly draw wort out into a pitcher regulating flow if needed. Collect wort until it begins to run fairly clear. Place the drainage tube in your collection vessel (boil kettle, buckets, etc.) and then dump that pitcher slowly over the top of the grain bed, and continue to drain the mash slowly. You may need to do this a few times until clear wort is achieved, shutting the valve off between collections. Once clear wort is achieved, you are ready to start sparging. There are two main types of sparging, **Batch Sparging** and **Fly Sparging**.

## <u>Batch Sparging</u>

Once your vorlauf is complete, you will continue to drain out your mash tun until it runs dry. This is known as your *first runnings.* Once you have collected these, you may begin to heat this up, or set it aside and wait until your sparge continues. Now dump your heated sparge water in one fell swoop over the grain bed. Headspace of your mashtun will have to be taken into account to accomdate all your sparge water at once, but this method of sparging avoids the need for an *HLT (Hot Liquor Tank);* mentioned below. Once you've added your water, stir up all the grains to break up any clumps or pockets, return the lid to your mashtun and give it 15 minutes to resettle. Not allowing the grain bed to resettle can result in a stuck runoff. Once the 15 minutes is up, vorlauf again until wort runs clear, and continue to slowly collect your *second runnings* with your first runnings. You will notice the second runnings will lose colour over the course of the sparge. Collecting these runnings in your boil kettle as opposed to buckets, and heating while you sparge, you will cut out alot of time in your brewday. Once your mash tun is empty, you're all done sparging and you can start or continue to bring your collected wort to a boil.

## <u>Fly Sparging</u>

Fly sparging is a continuous process that does not require collecting separate runnings. This does add a second vessel known as your *Hot Liquor Tank (HLT)*, where your sparge water ("hot liquor") is stored. This vessel is deployed for the duration of the sparge. A second cooler with a drainage valve is popular, but a kettle can be used as well. Consistent temperature during the length of the sparge is recommended. After you vorlauf and start to collect your runoff from your mash tun, you want to begin to slowly add your sparge water to the surface of the grain bed, keeping a constant layer of water on top. Keep the flow of liquids from both vessels regulated to allow for an efficient sparge duration to take place. Commonly a gravity based tier system will be used for liquid transfer, but pumps may be employed as well. Continue this process, keeping an eye on your flow rates until the HLT is empty, all the while collecting all runnings in your boil kettle or buckets. Once your mash tun is empty, you're all done sparging and you can start or continue to bring your collected wort to a boil.

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Sparging does allow for some flexibilty and once again, the apparatus and method is up to you and there are many options out there. Keep in mind the function that needs to take place, keep it smooth and worry free and you'll be good to go!

## EFFICIENCY & PH

Efficiency is simply how efficient the conversion of starch to sugar was during the mash. Efficiency is a comparison of the potential contributed gravity of the grist to the actual contributed gravity of the grist and is listed as a percentage. At the homebrewing level the average efficiency is 70-75%. There are many online calculators that can help you figure out your efficiency based on batch size, amount and type of grain used and wort gravity; all factors you plug in. Without using calculators, you can, through continual brewing, simply compare results from similar grain bills to see how they have changed.

Certain factors can affect the efficiency including mash temperature, mash length, grains used and how fresh they are. Other affecting factors are PH levels in the product water and mash. Water and PH are both important factors in brewing, but are easily neglected. PH is a scale measuring how acidic or alkaline (aka basic) something is, ranging from 0-14: 0-6.9 being acidic, 7 being neutral, and 7.1 to 14 being alkaline (basic). The water in your area can be of varying PH, and is definitely something to look into. The ideal PH range of your mash should be between 5.0 and 5.5 for optimum conversion. It is nothing to stress out over, mashing without water treatment will work, but it just may not be as efficient as it could. Grains do contribute natural acidity and with a fairly neutral water source, they will contribute enough to place your mash PH in an acceptable range for starch conversion. The study of water and PH is something you can pursue at your comfort and discretion to enhance your mashing experience.

# ALL GRAIN BREWDAY

*What follows are simple step by step guidelines for an all grain brewday based on the information given above. It is assumed that you have a basic understanding of sanitation in regards to brewing as well as basic equipment involved on the cool side. For a refresher, please see our Extract Brewday Instructions.*

**1.** Collect your strike water in your kettle and begin to heat it up to slightly above your target mash temperature. Have your mash tun clean and ready, and setup sturdy and stationary.

**2.** Once your strike water reaches the desired temperature, remove it from heat and pour it into your mash tun. Make sure any valves are shut!

**3.** Add all your milled grain, base and specialty, to the strike water. Stir thoroughly until any doughballs are broken up, and all the grain is evenly submerged and dispersed. Take a temperature to check if you hit your target. If you are unhappy with your temperature you can add boiling or cold water in small quantities to adjust if you wish.

**4.** Put the lid on your mash tun and begin to mash for at least one hour, keeping your temperature consistent. During the length of your mash, prepare any equipment needed for your sparge and begin to heat up your sparge water in your kettle.

**5.** Once your mash is complete and your sparge water is ready, begin your sparge by the method you have chose. Sparge slowly over the course of 30-60 minutes.

**6.** Heating up your wort as you collect it will help save time on your brewday. If you're unable to do this, once you have collected your wort and hit your target boil volume (slightly more than your batch volume) begin to heat it up to a full boil. Feel free to stir periodically.

**7.** While waiting for the boil get your bittering hops ready. If you are using hop bags (optional), put all the bittering hops together in your hop bag and remember to tie the bag close to the open end to give the hops freedom to move around. I recommend keeping the lid only partially on, or off altogether, while waiting for your wort to come to a boil again. You will see a froth form on the surface. This is a sign that your boil is about to kick-off. When the boil kicks off the froth may begin to rapidly rise. If this happens, rapid stirring while blowing on the froth should calm it down quickly along with slightly reducing the heat.

**8.** Once you get a rolling boil add your bittering hops. Follow your recipe directions regarding boil time, but 60 minutes is most common. Keep track of time for the duration of the boil, adding hops and other ingredients as per the recipe schedule.

**9.** Prepare your chiller. An ice bath won't cut it here brewing at these volumes. All chillers in brewing act as a heat exchanger. Cold water passes through the chiller and pulls the heat out of the wort resulting in the wort cooling down and hot water exiting the chiller. All water exiting the chiller will be very hot so be careful. If you are using an immersion coil, rinse it well and place it in the boil when you have 20 minutes remaining to sterilize, keeping any tubing away from your heat source. If you are using a counter flow or plate chiller make sure it and any related equipment has been properly cleaned and sanitised and is ready to accept your sweet wort.

**10.** Once the boil is complete, shut off the heat and begin your cooling procedures. Have your cold water hooked to the inlet of your chiller and turn it on, regulating flow as you see necessary to cool the wort as efficiently as you can. If you are using an immersion coil, creating a whirlpool in the kettle by simply stirring will help cut down on cooling time by allowing more wort to be exposed to more surface area of the copper. Plate chillers cool wort as it leaves the kettle and are often used along with a pump. With a ball valve installed on the pump, you can regulate wort and water flow as you transfer to balance your wort temperature. You want the final result to be room temperature wort when using ale yeast, and under 60*F when using lager yeast.

**11.** Once wort is cool, transfer to your fermentor. If you don't have a spigot for drainage on your kettle, you can use a siphon to transfer instead of lifting the whole pot to pour it. If you used a plate chiller, your wort will already be cooled in your fermentor. Splashing while tranferring at this stage is okay to help aerate the wort. You want to aerate the wort to provide oxygen for yeast health. Further stirring and agitating can be employed to aerate as well.

**12.** Use your thief to take a sample of the wort. Release your sample into your test cylinder. Place the hydrometer in the test cylinder with enough wort to allow it to float, for a proper reading. A thief is sometimes compatible with a hydrometer to sit inside it for an all-in-one gravity sample and reading. Take your reading on the **specific gravity** scale at the **bottom of the meniscus dip (** Next Page)**. This initial reading will be known as your **Original Gravity (O.G.)**. Record it.

**13.** After taking your reading, pitch (pour) your yeast into your fermentor. I recommend sanitising the pack of yeast, dry or liquid, with a spray bottle, and using a pair of sanitised scissors to open any pouches. Give your batch a good brisk stir to provide further oxygen for the yeast if you wish.

**14.** If you used a bucket, firmly put the lid on. Fill your airlock roughly halfway with no-rinse sanitising solution or water, and assemble it firmly wedged in the rubber stopper. Place the airlock and stopper into the hole of your bucket lid or carboy. After you put the airlock and stopper in the hole, push lightly on the top of the lid. If the float piece in the airlock rises and the water bubbles you have a good lid seal.

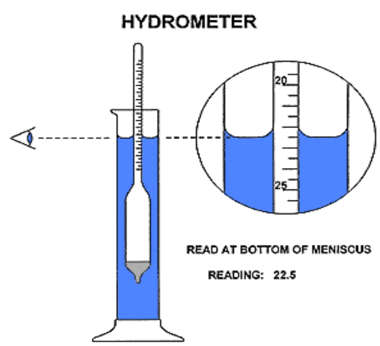
* You can also use a blow off tube in place of an airlock; a short length of food grade hose can be wedged inside the stopper with the other end in about an inch of sanitising solution or water in a (sanitised) jug or pitcher. This provides a liquid barrier and a path for fermentation activity just as an airlock would. Commonly used with higher gravity batches where fermentation activity will be vigourous.

**15.** Move your fermentor to the location where it will ferment. Somewhere clean, with a mild temperature in the room temperature range (66*F - 74*F) for ales, or cooler (48*F - 58*F) for lagers.

**16.** Thoroughly clean, rinse, and dry your equipment before your store it. Any brewer's grade detergent you mixed up earlier in the brewday can be used for this purpose. This will save alot of grime related headaches and heavy scrubbing later.

**17.** Sit back, relax, and enjoy the rewarding feeling of an accomplished day. You are now an All-Grain brewer. Have a homebrew to celebrate!

*****MENISCUS DIP (Read at Bottom)***




Make your best estimate when taking readings, as a hydrometer is a very finely graduated tool. I find the meniscus dip roughly equals 0.002 on the specific gravity scale.

# ***Fermentation***

Primary Fermentation for ales will typically last anywhere from 7-10 days and up to 2-3 weeks at the room temperature range (66*F - 74*F). Lager fermentations can take between 4-8 weeks depending on the fermentation temperature and yeast strain used; research is recommended.

Take another Hydrometer reading after this period to ensure fermentation is complete. This is known as your **Final Gravity (F.G.).** A common finishing range for most brews will be 1.008 - 1.014, but this can vary based on the type of yeast you used, and the amount of time your beer has fermented.

A good way to determine that a fermentation is 'ready' for transfer/bottling is to do this simple calculation:

Take your Original Gravity (O.G.), lets say it's 1.052.

**Minus the 1**
1.052 - 1 = 0.052
**Multiply by 0.35**
0.052 x 0.35 = 0.0182
**Add the 1 back in and round to three decimal places**
0.0182 + 1 = 1.0182 = *1.018*
*This final number* should be treated as your maximum final gravity before any transferring/bottling is done.

You can then prime and bottle, or transfer to a secondary fermentation vessel (commonly a glass carboy) for a period of your choosing. A typical length of 1 to 2 weeks is common for secondary fermentation (aging). Secondary fermentation allows for additional settling and flavour development and is an excellent time for additions of flavouring ingredients such as dry hops, ginger root, orange peel, etc. When transferring your brew, make sure to **siphon** the beer into the secondary vessel, and **not just pour it!** Pouring will create splashing and can leave you with oxidized beer. Aeration is only desirable when introducing oxygen into the wort for yeast health post-boil and cooling.

If your recipe calls for dry hops, they can be added in a Primary or Secondary fermentation vessel, depending on your choice. Secondary is recommended. If you choose to skip secondary fermentation, make sure to add the dry hops *after* primary fermentation is complete. Judge this based on your last hydrometer reading (Final Gravity). Regardless of your choice, let the dry hops sit in your beer for a minimum of 4 days to achieve the full affect.

## ***Calculating Your Alcohol Content***

*Just another easy calculation!*

**(O.G. - F.G.) x 131.25 = % alcohol**

**Example:**

**(1.048 - 1.012) x 131.25 = % alc.**
**(0.036) x 131.25 = % alc.**
**0.036 x 131.25 = 4.725**
**Rounded = 4.7%**