YEAST MANAGEMENT

HARVESTING & REUSING, STARTER CULTURES, & LONG-TERM STORAGE (FREEZING)

Note

The information and protocols described here are basic by design and, as a result, relatively imprecise, however, it will suffice for most of your homebrewing needs. If you require more detailed information or want to manage your yeast and brews more precisely, please refer to the listed references and adapt your protocols accordingly.

I. YEAST BASICS

Yeast is a single-celled living organism that grows and multiplies rapidly during fermentation. It typically doubles its population every 90-120 minutes and multiplies 10-20 times during a standard 20L fermentation. This means that you end up with more than a trillion (10^{12}) living yeast cells in the bottom of your fermenter which can be harvested and stored for future use. Hydrated yeast stored between 4 and 10°C (fridge) has a half-life of between 3 and 9 months, depending on the strain and storage conditions. Yeast cells can also be frozen and stored indefinitely at -20°C (freezer) for future use.

Harvesting and reusing, starter cultures and/or the long-term storage of yeast offers several advantages:

- **Cost savings**: Yeast is typically the second most expensive component of a homebrew recipe; reusing yeast will reduce the overall cost of brewing.
- **Improved yeast health and performance**: Properly harvested yeast and/or starter cultures can improve the health and performance of the yeast, leading to better fermentation efficiency and healthier beers.
- **Access to diverse strains**: When you store yeast you can develop a library of strains that may not always be commercially available and exchange strains with other brewers.
- **Experimentation and customisation**: When you can harvest, grow, and reuse yeast you can experiment, manipulate, and combine different strains to create unique flavour profiles.

II. HARVESTING AND REUSING YEAST

General notes

- *While reusing yeast offers many benefits, following proper sanitation and storage procedures to prevent contamination and maintain yeast health is critically important.*
- *There are limits to how many times you can reuse a yeast culture before it may begin to diverge from the original strain. Generally, it's not recommended to repitch yeast more than 5-7 times/subsequent harvests.*
- *You should not harvest yeast from high-gravity (>1.070) brews as the yeast is likely to be highly stressed and may introduce off-flavours in subsequent batches (see reference 1 for more details).*

What you'll need

1. The yeast cake from a recently completed fermentation.
2. A ~1L glass bottle with a screwcap that seals well. A recycled Jacobs coffee bottle (800ml capacity) works well.
3. No-rinse sanitiser.
4. A fridge (4°C).

Harvesting yeast after fermentation

1. Sanitise the bottle and lid – typically done as part of the bottling/kegging process.
2. Leave a thin (~5mm) layer of beer on top of the yeast cake in the fermenter.
3. Resuspend the top layer of the yeast cake in the remaining beer by gently swirling it around.
   - *The slurry's thickness will depend on the amount of beer left in the fermenter – less beer will give a thick slurry that is difficult to pour while a very thin slurry will limit the amount of yeast harvested. A "medium-thick" slurry is preferred. Consistent slurry thickness across different harvests will also help ensure consistent pitching rates.*
4. Carefully transfer the yeast slurry to the sanitised bottle. If you spill yeast onto the neck/thread of the bottle, clean thoroughly with a paper towel and sanitiser – you need a clean and dry seal.
5. Close the bottle tightly and label it with the yeast strain's name, harvest nr, and harvest date (Fig 1 (B)).
6. Store it in a fridge (4°C) until use.
   - *The yeast will settle in the bottle, leaving the top ~third with clear beer. For a medium-thick slurry, in a 800ml bottle, this means a sediment of ~500ml and beer of ~300ml, or 0.625ml trub per ml total volume (Fig 1 (A)).*
   - *You can typically store and directly use harvested yeast for up to six (6) months. Rather prepare a starter culture for older yeast to ensure the yeast's viability. Discard unused, harvested yeast stored at 4°C after 12 months.*

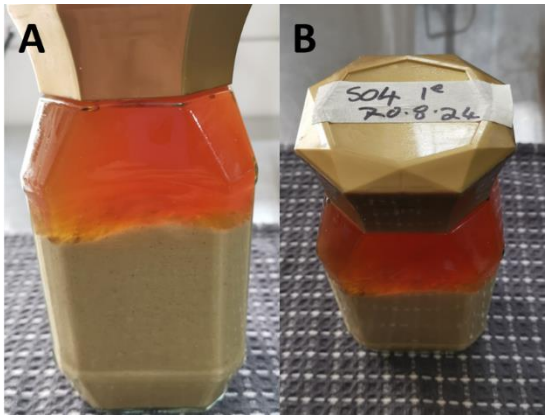

Figure 1. Harvested yeast. (A) Settled yeast cake in storage. (B) Clearly labelled yeast.

To wash or not to wash

If you did not dry hop or used dry hop bags there is no need to wash the harvested yeast, especially if you try to only harvest the upper layer of the trub.

- Should you have a lot of dry hops or other extraneous matter in the yeast cake and need to wash your harvested yeast, please refer to reference nr 2.

Pitching with harvested yeast

1. Remove the bottle of yeast from the fridge when you start brewing to allow it to slowly warm to room temperature.
2. When you are ready to pitch, sanitise the outside of the bottle and lid.
3. Shake the bottle to resuspend the yeast completely and then pitch approximately a quarter (¼) of the yeast (~200ml) into an "average" wort, i.e. a 20L batch with an average (± 1.050) SG.
   - Because we don't know exactly how much of the harvested trub is cells vs other material like proteins and fine hops residue, or how many of the yeast cells are still alive, we can't calculate the exact pitching rate. You must consider all relevant parameters and adapt the amount of trub you pitch accordingly. In addition to wort SG and volume you should also consider how thick and old the slurry is, the yeast's identity, etc.
   - For larger yeasts you can use double the amount of yeast, i.e. ~½ a bottle.
   - If required, you can again harvest yeast from the brew in which you used the final (4th) batch of your harvested yeast – this will then represent the 2nd harvest of the yeast. In theory, you can therefore brew up to 21 batches of beer (4/harvest x 5 consecutive harvests, plus the original brew) with a single packet of yeast.
4. Store the remaining yeast at 4°C until use.

III. PREPARING A YEAST STARTER

Note

I mostly make starters from yeast stocks that have been stored in the fridge for >6 months, so I like to grow them for at least two full days (≥48h) to verify their viability (visually growing, see Fig 3) and purity (smells like yeast). I therefore start the culture on a Wednesday evening to be ready to pitch on Saturday.

What you'll need

1. A ~1L glass bottle with a lid that can be placed in the microwave and handle boiling water, i.e. your culture vessel. A cheap option is an old Jacobs coffee bottle with the seal inside the lid removed – the starter culture must be able to breathe, never seal it tightly.
2. A magnetic stirrer & stirrer bar.
3. A ~5L plastic container to use as a temperature-controlled water bath.
4. An aquarium heater.
   - *If you don't have a magnetic stirrer and/or some form of temperature control you can still grow a starter "manually", but the lower oxygen levels & temperatures will impede the yeast's growth rate significantly.*
5. Consumables for growth media: dry malt extract (DME), sucrose (ordinary white sugar), & water.

What to do

1. Ensure your culture vessel is clean.
2. Add 25g sugar, 10g DME & a magnetic stirrer bar to the culture vessel.
3. Fill to 250ml with hot water (60-70^{o}C, not boiling).
   - *DME dissolves much easier & quicker in hot water.*
   - *25g sugar + 10g DME in 250ml water gives a growing media with an SG of ~1.050 & a pH of 5.0-5.2 when you use soft Helderberg tap water.*
4. Replace the lid <u>loosely</u> then swirl by hand to dissolve the DME & sugar.
5. Microwave until it starts to boil but stop immediately to prevent boil-over.
6. Repeat steps 4 & 5 another two times.
   - *These repeated boiling steps are to fully dissolve the DME & sterilise the media and inside of the bottle.*
7. Cool to room temp while stirring (Fig 2 (A)).
   - *Do NOT put directly in cold water to cool down quickly if you use a standard glass bottle - it will crack!*
8. Inoculate your media at least 48h before intended use with yeast stock.
   - *If you use harvested yeast (section II), shake the bottle to resuspend the yeast and use only ~20ml to inoculate the media.*
   - *If you use a frozen stock, pour the whole tube in after it has defrosted.*
9. Replace the lid <u>loosely</u> to allow air exchange then stir in the water bath at 24^{o}C for 48h.
   - *Place the plastic container with water and aquarium heater, set at 24^{o}C, on top of the stirrer, then place your culture vessel in the water bath (Fig 2 (C))(see reference 3 for more info on starter culture temperature).*
   - *Check to see if yeast is growing and smelling ok after ~12h. The culture will become lighter as yeast cell numbers increase (Fig 3) & it should smell like good, clean yeast – discard if it smells funky.*
   - *You could add another 250ml of sterile, fresh medium to the culture and stir for a further 24h if necessary or if you want a higher cell count/pitching rate (e.g. for lager yeast).*
10. Inoculate your wort with this culture.
    - *If you prepared a 250ml culture, decant everything into your wort.*
    - *If you prepared a 500ml (or more) culture. Stop stirring a few hours before pitching to allow the cells to settle, decant ~half of the media and inoculate with the remaining cell suspension; now with a higher cell density.*

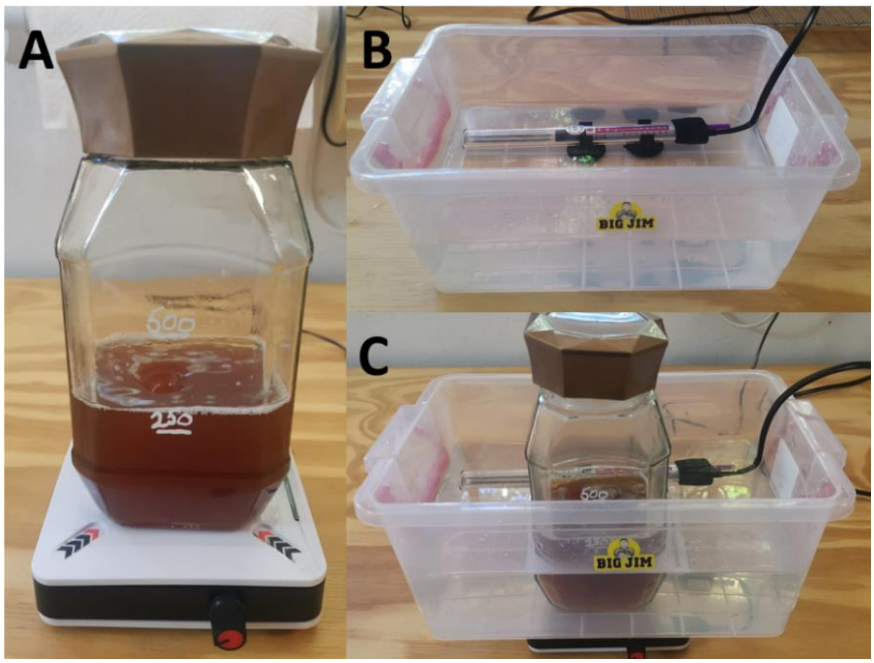

Figure 2. Example of a yeast starter culture set-up. (A) Culture vessel on a magnetic stirrer. (B) A five-litre water bath with an aquarium heater set at 24°C. (C) Culture vessel in the water bath, on top of a magnetic stirrer.

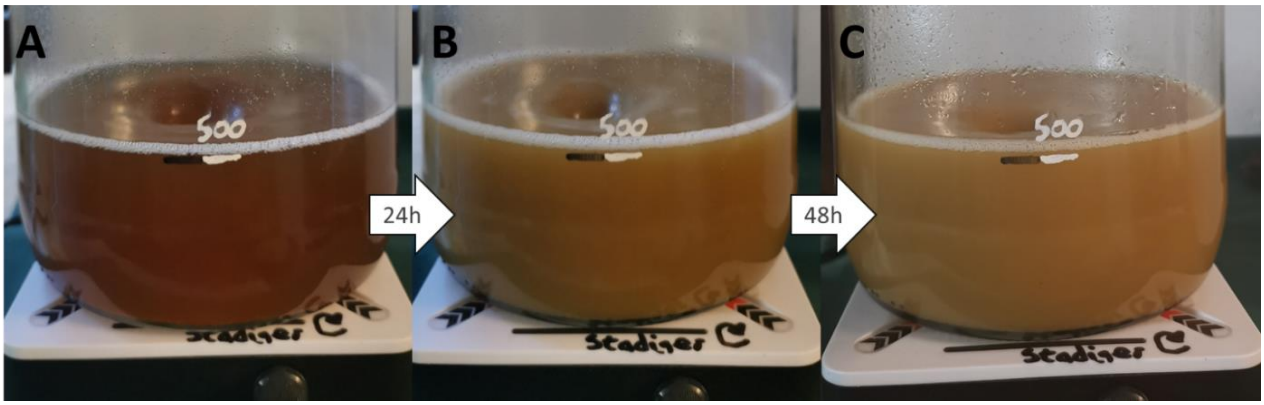

Figure 3. Visual comparison of yeast culture growth over a 48h timeframe. (A) Culture just after inoculation. (B) After 24h. (C) After 48h.

IV. FREEZING YEAST FOR LONG-TERM STORAGE

Notes

- *Freezing yeast allows long-term storage with minimal effort.*
- *Because the frozen yeast is not actively growing it remains true to type and can be stored indefinitely.*
- *If you freeze yeast in water or a water-based medium the ice crystals will cut and tear the yeast cells apart and destroy them. In addition, possible osmotic pressure differences may damage the yeast cells. To prevent these effects the yeast cells must therefore be frozen in a solution that limits the formation of ice crystals and osmotic shock, i.e. a cryo-preservation solution. In this protocol, glycerine, at a final concentration of 12.5% (v/v) is used to accomplish this.*
- *To further reduce the formation of large ice crystals the cell suspension must be frozen as quickly as possible. Methods that can be used to accomplish this include using very low temperatures (e.g. dry ice at -80°C), improving the heat exchange tempo (e.g. emerging the tubes containing the yeast in a cold liquid), and/or limiting the volume of the cell suspension that you freeze – the latter two are generally more attainable in a home brewery and therefore used here.*

What you'll need

1. An actively growing yeast starter of the strain you want to freeze away.
   - *It is not recommended to freeze away trub harvested yeast – using a pure, actively growing culture will increase the quality and viability of your frozen cultures.*
2. A short, ~200ml glass bottle with a microwavable lid.
   - *Used to prepare and sterilise the cryo-preservation solution. It must be short to allow solution extraction with a syringe, e.g. a 200ml Mason jar with a plastic lid (Fig 4).*
3. 20-40ml screw-cap storage containers.
   - Various options available at local plastic shops. 40ml specimen bottles work well (Fig 4).
   - You need to label these clearly with the date and the name of the yeast strain in the frozen culture. However, the ethanol in which you freeze the culture will wash the ink off. So, if you label them before freezing you must cover the text with sticky tape (see-through Sellotape) or label them after you remove them from the ethanol.
4. Glycerine
   - Available at CAB Foods, pharmacies, etc.
5. A 10-20ml syringe.
6. No-rinse sanitiser.
7. Approximately 1L of a 70% ethanol solution (e.g. hand sanitisers) in a small polystyrene cool box (or a ~2L plastic container, e.g. an ice cream tub) at -20°C (freezer).
8. A freezer (-20°C).

Figure 4. Materials required to prepare frozen yeast cultures. Including a short, 200ml Mason jar with a microwavable lid, 40ml specimen bottles, and a 10ml syringe.

What to do

1. Prepare a 25% glycerine (v/v) cryo-preservation stock solution.
   1.1. Add 40ml glycerine and 120ml water to the glass bottle and mix it well.
      - It may be easier to weigh these off – 50g glycerine + 120g water.

1.2. Microwave just until it starts to boil - stop immediately to prevent boil-over.
   - Remember to loosen the lid before boiling!

1.3. Rest the solution for a minute then repeat the boiling step two more times to sterilise the solution.
   - In references 4 & 5 you'll see that they sterilise the cryo-solution in a pressure cooker. The boiling point of water increases with pressure, resulting in a typical pressure cooker reaching ~120^{o}C which will destroy the toughest of microorganisms – also referred to as autoclaving. However, the 3x 100^{o}C boiling protocol described here should be sufficient if you work hygienically in a clean environment. The only contaminants that may survive this are fungal (mould) and rare bacterial spores, which are as likely to contaminate your starter cultures and brews. It therefore doesn't add value to autoclave only one of several components that could get contaminated.

1.4. Cool down and store in a fridge until use.

2. Pour approximately 1L of 70% ethanol into the small polystyrene cool box and cool down in a freezer for at least two hours to ensure it is as cold as possible.
3. Label the storage containers clearly with the yeast strain's name and the date and then cover the text with sticky tape to prevent the ink from washing off in the 70% ethanol.
   - If you prefer you can also label the tubes after the freezing step but then you'll have to deal with condensation.
4. Sanitise the storage containers and syringe thoroughly in no-rinse sanitiser.
5. Using the sanitised syringe, transfer 10ml of the cold cryo-preservation stock solution to each storage container.
   - Sanitise your hands and be careful not to touch non-sanitised surfaces with the syringe.
6. Ensure the yeast in the starter culture is fully suspended, then transfer 10ml of the yeast suspension to each of the storage containers.
7. Mix the cryo-preservation solution and cell suspension thoroughly and place immediately thereafter in the -20^{o}C 70% ethanol.
   - Do not freeze more than ~5 cultures per 1L ethanol because the temperature of the solution will then rise too much and not be able to freeze the culture quickly.
8. Transfer the whole container with the ethanol solution and frozen cultures to the freezer and freeze for at least two hours.
9. Remove the frozen cultures from the ethanol and store them in a freezer until use.

V. Pitching rate notes

- *Pitching rate* refers to the number of yeast cells added to the wort to initiate fermentation. It impacts "*how quickly fermentation gets going*", called the *lag* phase of fermentation. Too few cells will extend the lag phase, stress the yeast and increase the production of yeast-associated (off-)flavours, e.g. fruitiness. Conversely, too many cells will rush the fermentation, resulting in a thin, watery beer. Despite these impacts, a lot of leeway does exist, and the average homebrew will not be significantly influenced by quite variable pitching rates. You should, however, more carefully consider the pitching rate when you want to brew high-gravity beers and clean-fermenting lagers.
- Optimal pitching rates are determined by the type of yeast (lager vs ale) and the wort's volume and gravity (OG) – expressed as *millions of cells per ml per specific gravity point.* Pitching rate recommendations vary between 0.1 and 0.5 million cells/ml/SG point – equivalent to 105 to 750 billion cells per 20L batch. See an online calculator HERE.
- An 11.5g sachet of dry yeast contains ~110 billion viable yeast cells. Indicated in the spec sheet as >1 x 10^{10} cfu/g – which means 11.5 x 10^{10} cfu/sachet (cfu = **c**olony **f**orming **u**nits = viable cells).
- The above calculator suggests an average strength (OG = 1.050), 20L batch of ale should be pitched at around 185 billion cells, equivalent to almost two packets of dry yeast (18.5g). However, many homebrewers routinely use only a single packet with (arguably) no adverse impacts. Moreover, dry yeast manufacturers recommend pitching rates of 10-16g/20L batch.
- Another rule of thumb calculation for the pitching rate of dry yeast per 20L batch is:
  - 6.5g Ale yeast per gravity point divided by 25.
  - For 1.045 SG = 6.5(45/25) = 11.7g ≅ 1 packet.
  - Lager strains should typically be pitched at twice (2x) this rate, i.e. 13g(gravity/25).
- It is difficult to determine the exact pitching rate with self-harvested yeast because specialised equipment and techniques are necessary to ascertain how many viable cells are in the stored culture. In addition, yeast survival is impacted by many different factors. However, as previously mentioned, a lot of leeway does exist for pitching rates in a homebrew context. Experience and experimentation are your greatest allies when working with yeast. The above is a good base to work from but verify everything in your system and continue to test new approaches.

VI. REFERENCES

1. How To HARVEST and REPITCH Yeast https://www.youtube.com/watch?v=dz9fd-p6ntM&ab_channel=TheBr%C3%BClosophyShow
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