Caution: this information was transcribed from notes taken during the presentation. Errors in advice given below may be due to misinterpretation, and should not be attributed to the speaker.

Competitive culture and pathogens

- Cheeses have pH > 4.6
- Salt alone is not inhibitory
- Need combination of A_w and competitive microflora
- Mexican cheeses are acid curdled. The low salt in the recipe will make no difference to pathogens like *Salmonella*, *E. coli*, *Listeria*. This is when competitive culture in a process is important
- Competitive microflora:
    - In Lactic acid bacteria (LAB) fermentation, the LAB are the "bullies" and outgrow the pathogens ("wimpy kids on the playground").
    - The pathogens prefer not to grow at room temp, and prefer body temperature environments of 37°C.

  Yeasts and molds take longer to grow

Brewery questions

- When brewing, lines that dispense the beer can get black from molds, they should be clear. The molds are unlikely to be mycotoxin producing strains (not a food safety issue), but the quality of the beer will start tasting funky (food quality issue).
- Sanitary issues for lines include beer stone, biofilm formation, sanitation chemicals and residues
- One of the best disinfectants for breweries is still bleach – NaOCl, because it will dissociate into NaCl and H_2O (salt and water). Very safe.
- Other disinfectants that can be used include quats, iodine (but it turns everything brown). Phosphoric acid (named StarSan) can break up the beer stones, but afterward need to follow up with C&S

Sprouted seeds/grains and baked goods

- The main hazard associated with sprouted seeds/grains is *Salmonella*. It is problematic because it survives in low water activity (A_w) environments.
- In the U.S. sprouting must occur at refrigeration temperatures, and the seeds are treated by manufacturers with a hypochlorite solution.
- Bread – is a baked product and the exterior would have receive sufficient thermal lethality. The interior of bread can be moist inside and may not reach kill temps, so . check that the product or process is adequate. One cannot assume.

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Mold growth in beverages

- A double-shot of espresso is only pH of 6.5. This is high enough to allow mold growths. Most products should either be acidified (to allow room temperature storage) or held refrigerated for a maximum of 2 to 3 weeks.
    - *C. botulinum* (C. bot) will not grow at refrigeration temperatures in 9 days

Dehydrated foods

- Food safety question: Are you really "cooking" or "incubating" the product?
- Issues with raw foods and dehydration when temperatures are low, for e.g., 105°F (~40°C)\
- Under perfect conditions, *C. perfringens* and *B. cereus* can grow in 6 hours, and C. bot in 11 hrs. Temperatures between 42°C and 48°C are good growing conditions (~105 to 120°F).
- During dehydration, you need to start with 63°C (145°F) for one hour, and the material should be wet (as *Salmonella* is hard to kill in dry conditions). Temperatures should always be above 48°C, as *C. perfringens* can grow well up to that temperature.
- Max. growth temps for spore-formers: C. bot 48°C, *C. perfringens* 52°C, *B. cereus* 55°C, and for toxin producers, *S. aureus* 48°C
- For meat, and making jerky, pay attention to relative humidity. There were outbreaks of *Salmonella* in dried chicken jerky in Arizona, New Mexico and Utah because the R.H. was low, at 30%. Even though the dehydrator was set to 63 to 65°C, there was no kill effect.

[http://www.engineeringtoolbox.com/dry-wet-bulb-dew-point-air-d_682.html and http://www.fsis.usda.gov/wps/wcm/connect/5fd4a01d-a381-4134-8b91-99617e56a90a/Compliance-Guideline-Jerky-2014.pdf?MOD=AJPERES an RH of 90% to make jerky is needed]

- For meat curing, celery salt does contain nitrate, and in culture will convert to nitrite. 20ppm nitrite is adequate, 50ppm is better. Operators should be sending to the lab to get it tested to verify final concentration.

Fermented Foods

- You should see a good healthy active fermentation occurring within 24 hrs – this is 10^6 CFU/g active culture. Understanding your product specific process is important to establishing the "normal" rate.The best way to get a good active fermentation going is to seed with a fresh culture from a successful fermentation.
- There are no commercial starter cultures for sauerkraut and LAB fermentations.
- In some respects, we are "out-sanitizing" our fermentations. For e.g., with sauerkraut, we remove the outer dirty leaves (that have most bacteria on them). Then we sanitize the cabbage head and rinse it very well. We could end up with a low culture on the leaves, only 1 CFU/g,

when usually leaves on the outside with have 10^3 or more LAB CFU/g. This can result in a slow start to the culture.

- Hazards in fermented foods come from agriculture – such as *Salmonella* and *E. coli* and from poor sanitary handling. The reason these are the hazards is that they are tolerant to acid. Other bacteria die under acidic conditions or spores cannot germinate: *Clostridium* spp., *L. monocytogenes (L.m.)* and *Bacillus.*
- Agree, that in ideal conditions, you get to a pH of 4.6 or below in 48 hours. But, is the normal fermentation period takes 3 days to get down below 4.6, this is OK too. It's more important to see active fermentation, active bubbles within 24 hrs. If the bullies (LAB) aren't in the playground, that's when the pathogens might have a chance to grow.
- pH monitoring is useful to show a pH drop over a period of time, and to establish fermentation rate parameters for the process.Adding salt to fermentation is good, it is a pathogen inhibitor. Dry salting for fermentation is fine, it pulls moisture out of the leaves.
- Refrigerated fermented foods, the U.S. standard to operators is: either prove *L.m.* cannot grow in the food in the fridge, or, discard the food within 7 days. *L.m.* will not grow at refrigerated conditions of <5°C when the pH is ≤ 5.
- Shelf-life of fermented foods? Basically, until the food is "adulterated", or when the green fuzzies grow. In the U.S. claims for probiotics, for e.g., on yogurt, you need 10^6 CFU/g of culture or you can't make the claim. Generally these die off within about 6 weeks of packaging.
- General comments about fermentations:
    - the SAFETY is where no PHFs can grow; the QUALITY is when spoilage occurs, and foods start to go bad.
    - Don't top up fermentations, start fresh
    - Use labels, when fermentation started, shelf-life etc.
- Hot-sauce cold-filled (on-line question), pepper sauce that is non-acidified, with onions & spice. Doesn't appear to be any safety in this recipe. Fermentation will not occur in the bottle. Product needs to be acidifed prior to filling. In the U.S. cold-fill hot sauce is only permitted when the pH is 3.3, nothing will grow or survive at this pH. In the US, this type of product would require a process authority letter. Product could also contain a preservative to inhibit mold growth.
- Kombucha tea fermentations. These are dual fermentations, sugar is converted to alcohol is converted to acetic acid. These are open aerobic fermentations. The SCOBY or Sarcomyces (yeast) grows rapidly in the first 24 hrs, eating up all the sugar, then the alcohol is converted to acetic acid. In the U.S. the alcohol limit is <0.5% (it's <1.0% in B.C.). If you stop the fermentation too soon, by refrigerating, then you can get higher alcohol content. Typically the pH is <3.8. However, if you ferment too long, and the pH drops too low, i.e. to anything below a pH of 3.2, the fermentation is too acidic, and illnesses have occurred from esophageal burns.

Foods in oil

- Oils, when heated to high temperatures, e.g. 230°F (110°C), drive out all the moisture. C. bot and other organisms cannot survive in oil without any water. Will be okay if dried or fresh herbs are added to HOT oil.
- However, if you add a FRESH herb, that has moisture, then within that water layer, C. bot has a chance to grow. In the U.S. recommend to acidify, with ascorbic or citric acid, to drop the water phase to pH <4.6. These are good agents, because then the label can say "product contains vitamin C".
- If you add a DRY herb – what does that mean, exactly? Each operator's definition of dry is a little different. Even if dry herbs are added, still recommend to acidify.
- Cedar leaves crushed or pureed and added to oil. How long can it last if the product is not acidified? The hazard if you don't add acid is psychotrophic *C. botulinum*. The maximum refrigeration time is 9 days. The operator must prove the pH is <4.6.

Need to measure pH of water phase. NOTE: oil is damaging to pH probes. Cold pressed juices

- Hazards in these products are acid resistant *Salmonella* and *E. coli*. To limit growth of these organisms, need to keep temperatures below 10°C.
- Sanitation needs to be an important component of any cold pressed juice. Watermelon for e.g. is at a pH of 5.7 – in that case then you only have temperature controlling growth of the pathogens.
- Is food safety (temperature) outcome being met? Keeping product "on ice" versus "in ice"?
- Cold pasteurization with liquids under pressure is a method being developed for juices. The juice still needs a U.V. kill step. This new method uses a 15 in. long tube that is under pressure. Learn more from food engineering, Cornell University. https://ecommons.cornell.edu/handle/1813/39326

Acetic acid and CIMSEE model (https://www.dairyscience.info/calculators-models/177-cimscee-model.html) and (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1538705/)

- Acetic acid is lethal to most micro-organisms
- It only works if you can get the acid into the product, for vegetables, cauliflower has the least porosity, most difficult to get the acid in

Process authorities

- The definition of a process authority is that they are a credible food engineer or food microbiologist AND that they are believed by government to be a credible authority
- There are only ~12 in the U.S., and Brian is one.

- Industry / businesses may try to use the one Ph.D. they have in their operation as the process authority, but may not have the background, expertise or knowledge in that subject area to be credible.

Miscellaneous topics:

- FSMA and HARPC http://food-safety.guru/harpc http://food-safety.guru/archives/743
- Peanuts/almonds
    - Need to be pasteurized, using water and wet heat lethality
    - Raw nut cheeses, once ground, have *Listeria* and *Salmonella* as microbial hazards. This product doesn't ferment. Sell or freeze within 7 days. Can verify risk in product by checking pH and A_w.
- VBNC – viable but non-culturable cells. Should we be worried about these? In a food environment, *campylobacter* is very difficult to grow, very difficult to find. Food matrix contains salt, proteins, sugar and these limit VBNC concerns.
- Salsa bottling – this is a hot-fill-hold (jars are turned upside down). In the US, requirements are for a pH <4.1; the product needs to be heated to 185°F (85.0°C), held in the jar at 180°F (82°C) for 1 min, and turned upside down for 1 min to get proper seal. The reason for the pH requirement is that some spoilage organisms can grow down to pH of 4.2. this would be called a high acid home canned food.
- For soups packaged in plastic in a cook-chill or hot-fill, what are the hazards? In this type of process, the *L.m.* is dead, but viable *C. bot* (and *C. perfringens)* spores might persist. Need to heat to 90°C for 10 min to get a 6D (6-log reduction) of *C. botulinum*. If this heating isn't achieved, then the product needs to be refrigerated to <3.3°C, unless there is this "*C. bot* cook" step as described.
- Sushi rice: need a pH or 4.3 or below to control for *B. cereus*. Although 4.1 is common for *Salmonella,* this isn't the usual hazard in sushi rice. Or, you can use time as a public health control, 4 hours.