Fermentation: The Fine Line Between Fresh and Rotten

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Humans have been fermenting food since before the beginning of recorded history. There are examples of fermented foods in virtually every culture throughout the world. Not too surprisingly, the process of fermentation was discovered, not invented. Also, not surprisingly, archaeologists suggest that the earliest ferments were alcoholic beverages. Neolithic people in China were making alcohol from rice, fruit and honey. Some anthropologists even suggest that roughly around 10,000 BCE, mankind converted from a nomadic into an agricultural existence to grow barley to make into beer.

Fermented food products are celebrated by cultures around the world and have been integral to many cuisines for thousands of years. Think about Korean kimchi, Eastern European sauerkraut, and Indian spicy pickles. Fermented foods were somewhat forgotten in American food culture, but are undergoing a renaissance today.

Definitions

The science of fermentation is known as zymology.

When alchemists studied fermentation, the process was often interchangeably referred to as "putrefaction," meaning to allow the substance to naturally rot or decompose. Conversely, there are a number of animal-based foods from different parts of the world that are described as being "fermented." However, the term is erroneously applied to such foods because fermentation properly means the decomposition of carbohydrates, and since animal tissues are composed of proteins and lipids, and contain at most only traces of carbohydrates, the operative processes in the transformation undergone by these animal-based foods are actually putrefaction and rancidification.

Fermentation is the metabolic process in which sugars are converted to simpler molecules (such as acids and alcohols) often with the assistance of yeast or bacteria. As the bacteria digest the food, they give off by-products, primarily lactic acid, acetic acid, alcohol and carbon dioxide. Biologists use the term fermentation to describe anaerobic metabolism – the production of energy from nutrients without oxygen. During the metabolic process, texture and taste are transformed. As the food is broken down, nutrients become easier to digest and assimilate, and essential vitamins, like K and B-complex that our bodies cannot make, are produced.

Why was it so important?

Fermentation, along with dehydration, were incredibly valuable methods of food preservation. Canning, developed in the 19th century, is a relatively new innovation. Refrigeration is even more recent.

Fermentation extends the life of food in several important ways:

1) make food resistant to microbial spoilage and the development of toxins
2) make the food less likely to transfer pathogenic bacteria
3) preserve the food between harvesting and consumption
4) modify the flavor of the original ingredient and often actually improve the nutritional value

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Types of Fermentation

Yeast * Acetic * Mold * Lactic * Symbiotic or Mix

Yeast fermentation

- Refers to the metabolic activity of yeast on sugars.
- Waste products are carbon dioxide (*tiny bubbles*) and ethanol (*in the wine*)

Examples include:
Beer Wine
Bread (sour doughs are a mixed ferment that involves both yeast and lactic acid bacteria. Not probiotic because it's baked (which kills the good bacteria)

Acetic Fermentation

- Involves action of acetobacter, a genus that makes acetic acid from alcohol.
- Converts the ethanol in wine, cider, beer etc into vinegar
- Requires air – that's why when you make wine you need an airlock to keep acetobacter out.

Examples include:
Wine vinegar Malt vinegar Apple cider vinegar

Mold Fermentation

- Trickier to make

Example include:
Some cheeses Tempeh
Koji* (makes miso, sake, amazake, soy sauce)

* Koji is cooked rice and/or soy that has been inoculated with Aspergillus (a fungus) and is the base culture behind all the Japanese fermented food products.

Lactic acid fermentation or lacto-fermentation

- Involves the use of lactobacillus bacterial culture. Lactobacillus is an incredibly common bacterial genus of over 180 Sp. Some of the most common known are L acidophilus, L. casei, L. bulgaricus
- "Lactic" refers to the presence of lactic acid bacteria (LAB) and the production of lactic acid, not because there are any milk or dairy products necessarily involved. There are some LAB strains naturally present in dairy milk.
- LABs are present in soil and therefore all over plants. LABs are not the only bacteria that can create fermentation, they are just the most common ones found on food.

Lacto-fermented foods are foods that can be called probiotic based on their production of health enhancing bacteria. Probiotics are considered microorganisms that are believed to provide health benefits when consumed.

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2 ways to lacto-ferment:

1) introducing yeast or bacteria into the food to be fermented by adding a starter culture (such as whey) or
2) naturally by cultivating microorganisms already on the food

Examples include:

Sauerkraut	Sour Pickles	Cheese (some cheese are
Kimchi	Yogurt	further fermented by molds)

Preserving herbs with lacto-fermentation

Canadian *Herbes salées* (salted herb preserve) are a fermentation straddling the boundary of fermentation and salting for preservation. This is way of keeping herbs by salting them for winter time use. From the Cape Breton area of eastern maritime Canada and the Charlevoix region of Quebec. With it origins found in the traditional French *verdurette*. Use in omelets, bean dishes, stews – wherever salt and herbs are called for.

What's the difference between fermentation and vinegar pickling?

Pickle is a confusing term because it is used to refer to both the brined and vinegar-based foods. The origins of the word pickle are actually from most likely the old English or Dutch word for "brine."

Fermentation is the action of live bacteria and therefore by nature an unpredictable process that can be hard to control. Commercially most pickles use vinegar and heat to preserve food rather than allowing the acidifying LABs to preserve the food. Vinegar pickles are not probiotic since the vinegar and heat destroy all the bacteria.

Bacteria/yeast/mix ferments (symbiotic fermentation)

- Symbiotic colony of bacteria and yeast (SCOBY)
- Cultures that combine action of yeast and bacterial symbiotic communities of bacteria and yeast
- Work together to create their physical structure, a matrix of cellulose
- In kombucha SCOBY, the yeast consumes the sugar in the tea and produces waste products which are in turn consumed by bacteria and used to create SCOBY and kombucha

Examples include:

Milk kefir	Kombucha	Sourdough bread
Water kefir (tibicos)	Ginger beer plant	Ginger bug

What is the difference between milk kefir and water kefir?

Milk kefir and water kefir are both probiotic-rich beverages. They are both made by using a live active yeast and bacteria starter culture called kefir grains. Milk kefir is propagated in milk and water kefir is propagated in sugar water. Milk kefir tastes like a tart, slightly carbonated milk. It can be used plain or flavored, and can be used as a substitute for buttermilk or yogurt. It has a much thinner consistency than yogurt. Water kefir has a sweet, slightly fermented flavor, and is slightly effervescent. Water kefir can be flavored with fruits or fruit juices and used as a soda replacement. Both can be used as starter culture for fermenting fruits or vegetables. While both have beneficial yeasts and bacteria, milk kefir has more. The taste of the two, however, is obviously significantly different.

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What is the difference between milk kefir and yogurt?

Both kefir and yogurt are cultured dairy milk products. Kefir is generally a little more tart than yogurt. They are both good sources of protein, calcium, potassium and B-vitamins. They both contain beneficial bacteria, though kefir contains about 12 times more varieties of bacteria. The bacteria in yogurt are often referred to as "transient" because they generally move through the digestive tract. The bacteria in kefir tend to colonize in your gut.

Everyday foods that you might not realize are fermented

- **Vanilla**: under-ripe pods are picked (before splitting) and go through a 6 month process where beans are soaked in hot water, rolled in blankets to 'sweat', dried on plats in the sun to evaporate water, then stored in a ventilated room to slowly ferment, when the unique aroma and flavor develops
- **Black Peppercorns**: unripe green fruits that are sun dried after fermenting. The fermentation process is what turns then black
- **Tabasco**: Peppers are chopped up and mixed in salt that is mined on Avery Island, then poured into oak barrels to ferment up to 5 years
- **Coffee**: After picking, the berries are crushed to loosen the pulp, then fermented which develops and enhances the flavor
- **Tea**: All teas are oxidized, but some such as pu-erh undergo fermentation
- **Chocolate**: Fermentation removes the bitterness and imparts complexity

Others:

Crème fraiche	Fish sauce	Sour cream
Salami and other cured meats	Kuasi	Worcestershire sauce

Why are bacteria good for us?

- LABs are present in our bodies and interact with the other bacteria in our bodies.
- LABs help regulate stomach acidity and produce acetycholine to stimulate the stomach muscles to push food into the intestine.
- Probiotics predigest nutrients and turn complex carbs into simpler, easier to digest, components. They're like little biological food processors - so we don't have to work as hard
- Nutritional enhancement: Probiotics manufacture and supply us with vitamins A, the full complex of B-complex and K.
- Vitamin C: Fermented foods contain large amounts of vitamin C, which our bodies can't synthesize. Fermentation does not add to the vitamin C amount, unlike with the B vitamins, but it does preserve the Vitamin C by dramatically slowing down its loss. Captain Cook was famously credited with conquering scurvy by bringing barrels of sauerkraut on long sea voyages.
- They break down fiber and use it to fuel their own growth
- More recent research point to the important role bacteria play in the immune system. 1) as a physical protective barrier to pathogens and 2) as a stimulant to increase the immune cell function and response. Evidence of an active biochemical dialogue is coming to light between intestinal bacteria and the immune cells of the intestinal wall. It seems these bacteria are essential to life

- Detoxification: fermentation can remove some toxins from food and make them safe to eat. For example, high cyanide containing bitter cassava root (yucca and manioc) is made safe to eat after several days of fermentation by soaking in water.
- Phytates (found in all grains and legumes, seeds and nuts) are 'anti-nutrients' that bind to minerals and stop them being absorbed. During fermentation enzyme called phytase releases minerals from this bond, increasing ability of body to take up minerals. Eg idli batter compared before and after fermentation showed significantly increased bioavailability of both iron and zinc.
- Fermentation makes contaminated water safer to drink by adding fermentable sugars and allowing a small accumulation of alcohol and acids to destroy bacterial contaminants. (remember our talk on herbal sodas when we talked about the consumption of 'small' beers in medieval Europe instead of water because it was safer)
- Most fermented foods are acidic (except for natto and dawadawa – a Japanese soy ferment - slimy coating on beans and a west African fermented condiment that turns a range of inedible plant seeds into something edible). Yet acidic ferments are actually considered to have an alkalizing effect on the body.

So how do we know it's safe?

- The process is resolutely against the grain of modern day thinking about food hygiene. In the realm of fermenting raw plant material, it's said that this fear is unfounded.
- The rapid proliferation of these acidifying bacteria make it difficult for pathogenic organisms to get established, even if they are present in the food being fermented. The LABs also give off other inhibiting substances such as hydrogen peroxide, bacterocins, and other antibacterial compounds.
- Recent disease outbreaks due to bacterial contamination of raw veggies – it might be argued that fermented foods are safer than raw.
- The critical aspect of the action of LAB is its self-protection. The lactic acid they produce inhibits the growth of other bacteria that might decompose or spoil the food.

Fermented foods won't last forever. Shelf life depends on storage temperatures, the amount of salt used, and the type of ferment. The line between what is fermented and what is rotten is a blurry one. Someone described fermentation as "controlled spoilage." Between fresh and rotten is a zone where some amazing flavors can arise. Some refuse to eat Roquefort or Stinking Bishop cheeses, and others consider them a delicacy!

Recipes

Fermented Herbal Mix (from Sandor Katz)

Use whatever herbs are available in abundance (basils, oregano, parsley, scallions, chives, garlic and a bit of hot pepper).

Chop/mince the herbs, add a salty brine and ferment at room temp for 3 days. Store in refrigerator.

Use it by adding a spoonful to vinegar and oil for a flavorful salad dressing. Or add it to a milk kefir for a creamy dressing or dip. Add a spoonful to a soup for a jolt of flavor.

Ginger Carrots (from Fresh and Fermented)

1 Quart sized jar
2.5 lbs carrots
2 Tbs sea salt
6 tsp grated ginger root, unpeeled

Grate carrots and ginger root by hand or in food processor. Put in a large bowl with the sea salt. Massage and squeeze the shredded carrots and ginger thoroughly to mix all together. Let sit 10-15 minutes until the mixture is very wet.

Pack into the jar, pushing down with a wooden spoon to pack tightly and remove any air pockets. Once all the carrots are submerged below the surface of the brine, place a weight on top to keep everything below the brine surface. Seal loosely and leave out on the countertop for 4-6 days. This will start to bubble and may spill over, so place the jar in a bowl. Taste and once ready store in the refrigerator.

Fermented Chili Peppers

2 c jalapeno or Serrano peppers, sliced into rings
3 c filtered water
2 tsp sea salt

Place the peppers in the jar. Mix salt into the water and pour over the peppers until submerged. Pack them down and place a weight on top so that they remain under the surface of the brine. Seal and set aside for a week or so. Store in the refrigerator.

Moroccan Preserved Lemons

6 Organic lemons
¼ c Salt
Additional lemon juice if needed
Bay leaf, cinnamon sticks, peppercorns, cloves - optional flavoring

Wash the lemons thoroughly. Either cut into individual segments or as is traditional make 2 cuts from one end, into 4 partially joined quarters, leaving an inch at one end intact. Massage the salt into all the surfaces of the lemons and pack them down tightly as you can into a jar. Push the lemons down quite hard to squeeze out the juice until the lemons are completely submerged in their own juice. Add more juice if needed to cover completely.

Moroccan Chicken with Preserved Lemons, Cinnamon and Green Olives

Serves 4

1 chicken cut up into pieces
½ tsp ground ginger
several large sticks of cinnamon (at least 4)
large pinch of saffron ground up into a powder
salt and pepper
3 Tbs olive oil
2-3 cloves garlic
1 large onion fine chop
large bunch parsley , fine chop
large bunch cilantro, fine chop
peel of 1 preserved lemon, rinsed and cut into small pieces
2oz green olives
1 ½ pints water or chicken stock

Clean and chop up chicken into pieces. Sauté chicken in olive oil. Remove to a plate, sauté onion. Add chicken pieces back into pot, together with spices, and 1 ½ pints water or chicken stock and salt and pepper.
Cook for 45 minutes covered wither on stove top or baked in oven. Add peel and the drained, rinsed olives and cook for a further 15-20 minutes.
Serve hot with couscous to soak up the juices

Razzle Dazzle Fizzle Berries (adapted from Charlotte Pike's Fermented)

Makes one 1 quart jar

Enough berries and cherries (pitted) to fill your jar ~ 5 cups
6 Tbs. water kefir
½ cup superfine sugar
Pinch sea salt

Fruit should be free of bruises and mold. Rinse fruit. Gently add the fruit to the jar. Avoid squishing and bruising the fruit. Pour in the kefir water, sprinkle in the sugar and salt and press the fruit down firmly so it is completely submerged. Fasten the lid on your jar. Allow the berries to ferment for 24-48 hours. You will need to burp the jars every 12 hours or so. Place the jar in the fridge after 24-48 hours. Best if enjoyed within a week.

Basic Fermented Vegetables (adapted from Charlotte Pike's Fermented)

Makes one 1 quart jar

~5 cups vegetables
2 cups filtered water
¼ cup water kefir
2 tsp. – 2 Tbs. sea salt

Pack the prepared vegetables into a 1-quart glass jar.
In a separate jar, mix filtered water with water kefir and 2 tsp. – 2 Tbs. sea salt. Shake until all dissolved, then pour over the vegetables. All vegetables must be fully covered. Set aside on the

countertop for 5 days. You will need to burp the jars every 12 hours or so. When the vegetables are ready to eat, they will be slightly softened.

Suggestions:

- Carrot sticks with dill
- Cauliflower with garlic and 1 Tbs. curry powder, 1 Tbs. chili powder, 1 tsp. cayenne, 1 tsp. turmeric
- Green beans with garlic and basil and rosemary

Trouble shooting surface molds and yeasts

It is common to get a layer of molds and yeasts at the surface if the veggies are peeking out. You want your veggies completely under the brine – protected from oxygen and protected by the LABs. At the surface the veggie rich juice is in contact with oxygen. This is a perfect environment for a diverse range of yeasts and molds to grow. Most sources say it is okay to remove this surface mold and make sure the veggies are submerged, and all should be fine below the surface of the brine.

If the whole thing turns pink or smells bad in any way then throw it out. It should smell pickly and taste pleasantly pickly and sour. Use your common sense. If it smells or tastes bad then don't eat it.

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