What is Cheese?

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What will we cover

- What is the makeup of milk
- How do we modify the milk to extract the solids and make cheese
- What is the general cheese making processes and how these effect the outcome

What is Cheese?

- Basically the extraction of the solids from mammalian milk. Fat and Protein
- "Average" milk composition (1 G = 8.6#):
  - 87.6% water (7.5#)
  - 12.4% solids (1.1#)
    - 3.7% Lipid (milkfat) (5.25oz)
    - 8.7% Non-fat milk solids (12.35oz)
      - 3.3% Proteins
      - 4.7% Carbohydrate (Lactose)
      - 0.7% Ash

Milkfat in other species

SPECIES	FAT	PROTEIN	LACTOSE	ASH	TOTAL SOLIDS
	%	%	%	%	%
Antelope	1.3	6.9	4	1.3	25.2
Cow:					
Ayrshire	4.1	3.6	4.7	0.7	13.1
Brown Swiss	4	3.6	5	0.7	13.3
Guernsey	5	3.8	4.9	0.7	14.4
Holstein	3.5	3.1	4.9	0.7	12.2
Jersey	5.5	3.9	4.9	0.7	15
Zebu	4.9	3.9	5.1	0.8	14.7
Goat	3.5	3.1	4.6	0.79	12
Sheep	5.3	5.5	4.6	0.9	16.3
Camel	4.9	3.7	5.1	0.7	14.4
Reindeer	22.5	10.3	2.5	1.4	36.7
Buffalo, Philippine	10.4	5.9	4.3	0.8	21.5
Seal, gray	53.2	11.2	2.6	0.7	67.7
Bear, polar	31	10.2	0.5	1.2	42.9
Cat	10.9	11.1	3.4	---	25.4

Milkfat (3.7%)

- 98% Triglycerides
  - Glycerol backbone
  - 3 fatty acids
    - Long chain fatty acid
      - What the animal eats
    - 75 different triglyceride combinations
- This is what creates the flavor
- Creaming ability

Proteins (3.3%)

- 80% Casein Micelles
- 20% Whey Proteins

	Whey Protein	Caseins
pH 4.6	Soluble	Insoluble
Chymosin (rennet)	Soluble	Insoluble
Heat (boiled)	Insoluble	Soluble

Caseins

- Micelles, particles
- Like a Kush ball
  - They have protruding branches like hair
    - These are called k-Caseins
- With the k-Caseins intact the caseins will not stick together
- This is why milk doesn’t clump together

Whey Proteins

- Become soluble in lower pH
- Also soluble in the presence of chymosin.
- In some business models the whey protein is the main product. Cheese is secondary.

How is a gel formed?

- A gel is the same as the curd.
- Forms when the casein micelles stick together to form a matrix trapping the larger milkfat globules.
- Chymosin is the enzyme that breaks the k-Casein bond.
- The casein micelles will stick together when the k-Casein bonds are snipped.

Things that interfere with curd formation

- Homogenization
  - This process forces the milkfat globules to be much smaller.
  - The milk doesn’t separate with the cream floating
  - This makes it easier for the milkfat to move in the curd thus making a softer curd.
  - Raw, non-homogenized milk will form a better curd, but homogenized milk works fine in most cases.

Things that interfere with curd formation

- Pasteurization
  - Milk is heated to kill dangerous microbes
  - The heating process denatures some of the whey proteins, breaks them apart.
  - These enzymes from the denatured whey will attach themselves to the k-Casein bond.
  - This will interfere with the Chymosins' ability to break the k-Casein bond.
  - A softer curd will be formed.
  - If to high a heat, like in ultra-pasteurized milk, all the whey protein is broken down and no curd can form.
    - This is the "scum" formed on boiled milk.

Things that aid curd formation

- Ionic Ca is necessary to help hold the curd formation.
  - Some Ca is destroyed in the pasteurization process.
  - To much Ca and you can't stretch the curd as in mozzarella
  - To little and the curd will crumble, as in feta
  - This is why we sometimes add CaCl to the milk.
    - It depends upon what type of cheese you're making

More things that aid curd formation

- Heat helps the milk coagulation
- Acidity
  - lower pH makes the whey proteins soluble while the casein proteins remain insoluble
    - A result of culture addition
    - Direct acidification (fresh non-aged cheeses only)
- Cultures
  - The bacteria converts the lactose into lactic acid
  - The lower pH aids in the curd formation
  - The enzymes help in the curd shrinkage and flavor

Summary

- In order to get the best curd formation:
  - Use non-homogenized milk
  - Add CaCl depending upon the cheese type
  - Use low temp pasteurization (or none if aged)
  - Add culture or direct acid
  - Set to correct temperature
  - Check pH and do not add chymosin until pH has dropped. This indicates that the culture is working.
  - Add chymosin, mix gently and let sit.

The Cheese Making Process

- This is a general review of the cheese making process. Not how to make any particular cheese.
- Broken down into the following steps:
  - Standardization
  - Acidification or Ripening
  - Additives
  - Gel Production – Coagulation
  - Curd Processing
  - Pressing
  - Rind Preparation
  - Aging and Curing
- Not all cheeses use all these steps

Standardization

- This is the process of getting the milk to a known chemistry prior to proceeding.
- May use low fat or whole milk
- May add cream or powdered milk
- More important in a production type environment where consistency in more important.

Acidification or Ripening

- This is the process of lowering the pH.
  - Gets the whey protein soluble
- Converts Lactose to Lactic Acid
- Can be direct acidification
  - Lemon juice, vinegar, citric acid, tartaric acid
- Culture ripened
  - Mesophilic (low temp)
  - Thermophilic (high temp)
  - Buttermilk, Flora Danica

Additives

- Bacteria or mold to create a particular flavor profile:
  - Biovar diacetylactis – Diacetyl production, buttery
    - Gouda, havarti
  - Propionic shermanii – CO2 production, holes
    - Swiss, emmental
  - Penicillium candidum – white mold
    - Camembert, brie
  - Brevibacterium linens (mixed in) – odor producing
    - Limburger
  - Brevibacterium linens (sprayed on) – red mold
    - Muenster

Gel Production

- Create the curd
- Separate the whey from the milk fat
- Use chymosin (rennet)
- Can be animal, vegetable, or genic engineered
- Once added to the milk it must not be disturbed until set.

Curd Processing

- The purpose is to expel the whey from the solids to get the consistency needed for your cheese.
- Two basic processes:
  - Drained and hung
  - Cut

Curd Processing – Drained and hung

- The curds are spooned into a cheesecloth and then hung to drain for one or several hours.
- The longer it drains, the dryer the cheese.
- Once drained the cheese can be finished with salt and eaten
  - Chevre, Cottage Cheese, Ricotta
- Or it could be heated and stretched
  - Mozzarella, provolone
- Ready to eat

Curd Processing – Cut

- Cutting the curd releases whey from the gel
- The finer the cut, the more whey that is expelled
- Can be cut pea sized to ½” or more
- Generally used with cheeses that will be pressed and aged
- Once cut the curds can be processed in a number of ways.

Curd Processing – Cut Curds, washing

- Various finishing methods have different effects on the final curd
  - Heating the curds and whey before draining releases more whey
  - Cold wash, replace part of the whey with cold water
    - Lowers pH without releasing more whey
  - Hot wash, replace whey with hot water
    - Lowers pH and promotes the release of more whey

Curd Processing – Cut Curds, finishing

- Processes for the drained cut curds prior to pressing
  - Salting
    - Flavor, expresses more whey
  - Cheddared
    - Cut curds are stacked and allowed to knit together
  - Milled
    - Blocks of curds are cut into smaller pieces
  - Pickling
    - Brining as in feta

Pressing

- Using weights and molds to form (knit) cheese into a particular shape
- The weight forces out more whey, making a harder, drier cheese
- Can be several pounds to over 50 pounds

Rind Preparation

- Once the cheese is pressed it is ready for aging
- Either to keep the rind clean or to promote mold growth
  - Salting
  - Salt wash
  - Brining
  - Washing
  - Mold application
  - Add holes
- Waxing is the final process to protect the rind while the cheese is aging.

Aging and Curing

- Some cheese may need to be aged from several days to over a year
- Long term aging allows the bacteria grow and then breakdown adding flavor to the final cheese

All done!

- Ready to make some cheese?