

Medieval Food Preservation Techniques in Our Modern Food Safe World

Arwyn of Leicester

What we will discuss

- Introduction
 - Where are you from? Why are you taking the class? What do you want out of it?
- Main Product Properties that affect Food Preservation
- Main Processing Parameters that affect Food Preservation
- Compare Documented Medieval Recipes/Techniques versus the above
- Explore Research to Support Eating Proper Food and not rotten meat
- Recent Paper Discussing Quince Preservation and evolutionary choices

Main Product Properties

Water activity
(a_w)

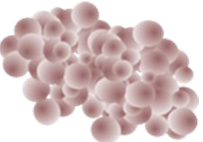





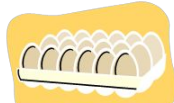


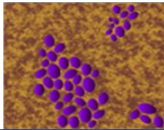


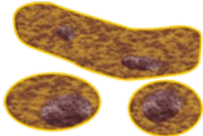
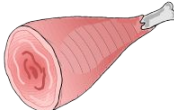





pH



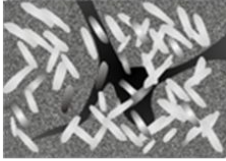
Composition

**Initial
microbial load**

Initial Microbiological Load - Some Common Food Pathogens

Picture	Name	Main products affected
	<i>Staphylococcus aureus</i>	 Meat  Lettuce  Dairy prod.  Ready meals
	<i>Salmonella</i> spp.	 Egg products  Poultry  Seafood
	<i>Listeria monocytogenes</i>	 Dairy prod. (cheese)  Meat products
	<i>Clostridium botulinum</i>	 Ham & processed pork  Fish  Canned vegetables
	<i>Clostridium perfringens</i>	 Meat  Poultry

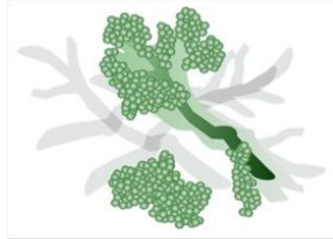
Oxygen Requirements for Microorganisms



**Strictly anaerobic
organisms**



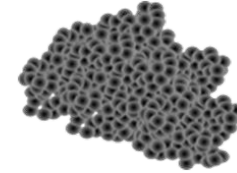
Clostridium, etc.



**Facultative anaerobic/
aerobic organisms**



Yeasts,
coliform bacteria,
Salmonella, etc.



**Strictly aerobic
organisms**



Moulds,
Pseudomonas, etc.

What is Water Activity (a_w)?



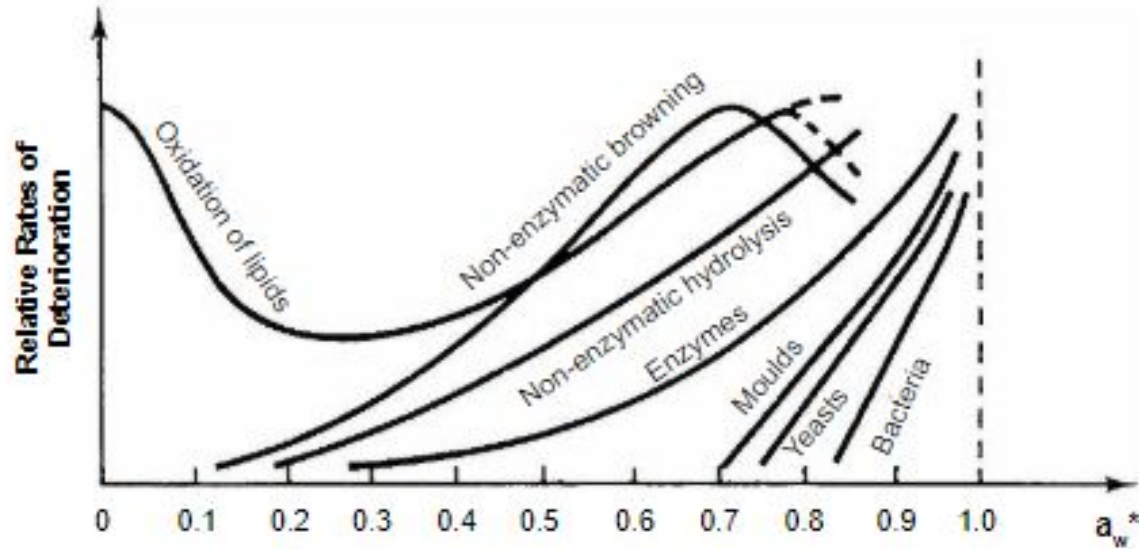
$$a_w = \frac{\text{Vapour pressure of } \mathbf{food}}{\text{Vapour pressure of } \mathbf{pure\ water}}$$

Availability of water in foods vary:

- Readily available => free, supports biological & chemical reactions
- Remainder => bound

Moisture content is the total amount of water in the food...
different!

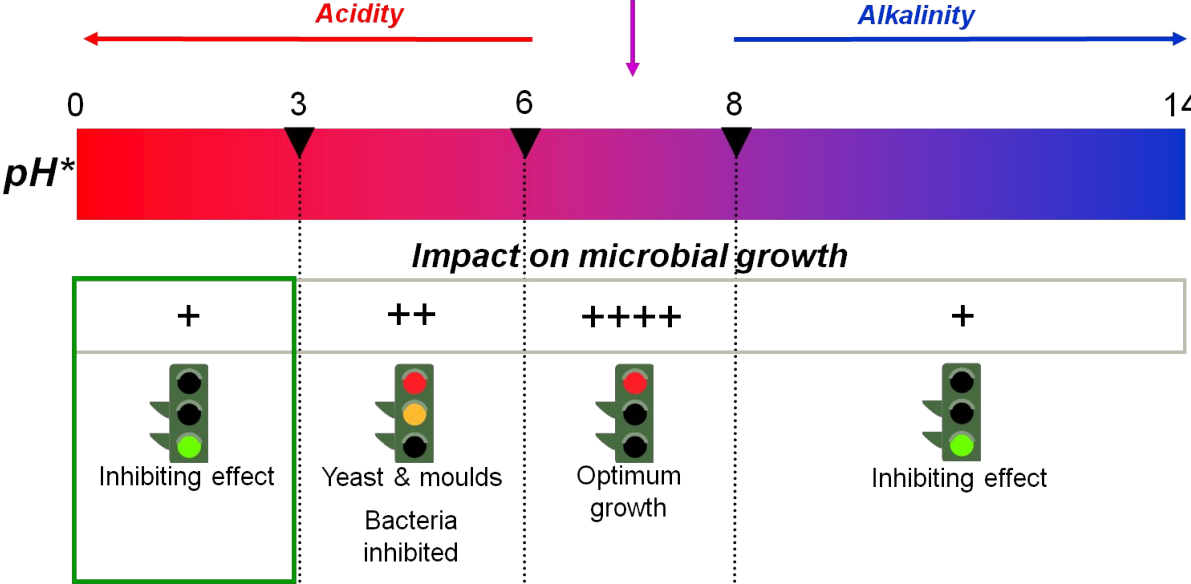
Water Activity versus Rates of Deterioration



Stability of foods as a function of water activity (adapted from Labuza)

* free/ "bound" water

Effect of pH on Microbiological Growth



$*pH = -\log_{10}[H_3O^+]$

Composition - Fats



Fish



Dairy products



Oils & Fats

- Foodstuffs rich in unsaturated fatty acids turn rancid (oxidation), with possible formation of off-flavors (aldehydes, ketones)
- High fat content in pork

Composition - Spices used for Microbiological Inhibition

	Food Pathogen Inhibition				
Spice	<i>Staphylococcus aureus</i>	<i>Salmonella</i>	<i>Listeria monocytogenes</i>	<i>Clostridium botulinum</i>	<i>Escherichia Coli</i>
Cinnamon	Inhibiting	Inhibiting	Inhibiting		Inhibiting
Cloves	Inhibiting	Inhibiting	Inhibiting	Inhibiting	Inhibiting
Cubeb	Inhibiting				Inhibiting
Cumin	Inhibiting				Inhibiting
Galingale	Inhibiting				Inhibiting
Grains of Paradise	Inhibiting	Inhibiting		Inhibiting	
Ginger	Inhibiting				
Long Pepper	Inhibiting				Inhibiting
Mace	Inhibiting				
Nutmeg	Inhibiting	Inhibiting	Inhibiting		Inhibiting
Pepper	Inhibiting			Inhibiting	Inhibiting

(Parthasarathy, Chempakam and Zachariah 2008) (Latha, et al. 2005) (Odetunde, Adekola, Avungbeto, & Lawal, 2015) (Khan & Siddiqui, 2007) (Chudiwal, Jain, & Somani, 2010) (ALLAHGHADRI, et al., 2010)

Composition - Salt Content and Water Activity

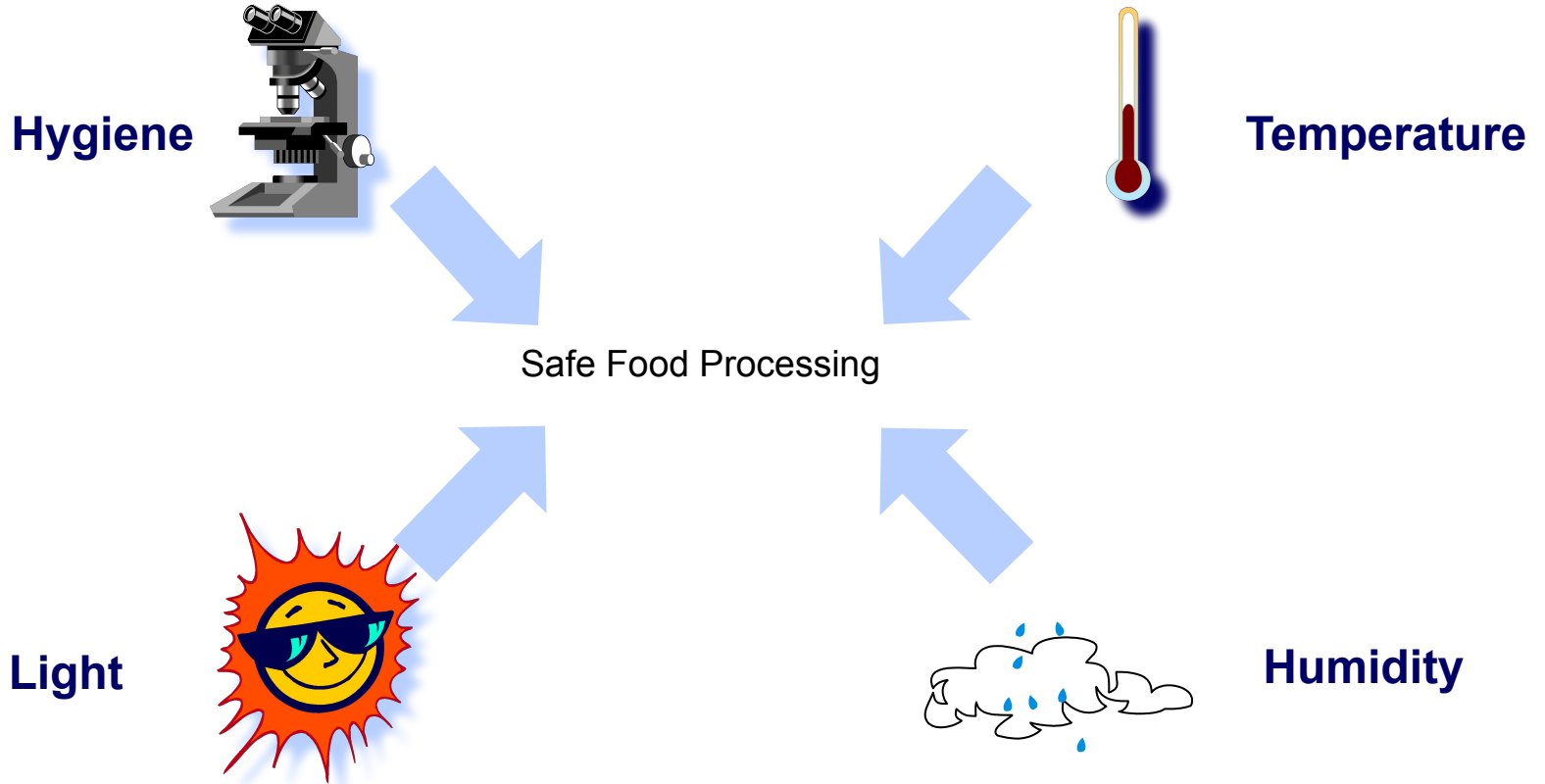
Salt/NaCl (g)	Water (g)	% NaCl	Water Activity A_w
0.9	99.1	0.9	0.995
1.7	98.3	1.7	0.99
3.5	96.5	3.5	0.98
7.0	93.0	7.0	0.96
10.0	90.0	10.0	0.94
13.0	87.0	13.0	0.92
16.0	84.0	16.0	0.90
22.0	78.0	22.0	0.86

<http://ucfoodsafety.ucdavis.edu/files/133655.pdf>

Composition - Sugar Content and Water Activity

Sucrose (g)	Water (g)	% Sucrose	Water Activity A_w
0	100	0	1.000
20	100	16.7	0.998
40	100	28.6	0.969
60	100	37.5	0.955
80	100	44.4	0.941
100	100	50	0.927
120	100	54.5	0.913
140	100	58.3	0.900
160/	100	61.5	0.888
180	100	64.3	0.876
200	100	66.7	0.860

Processing Parameters that affect Food Preservation



Hygiene: Key Factor

Working environment/ Air



Food handlers



Garments



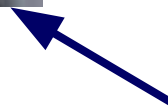
Raw materials



Equipment & utensils



Floor



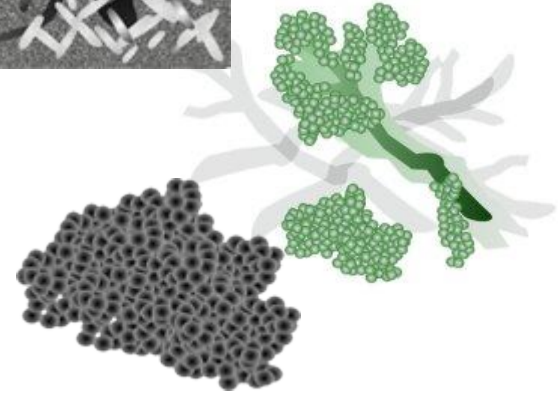
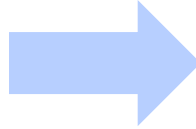
Temperature and Microbiological Growth



+140°	No germ, no danger	Sterilization
+100°	Destruction of vegetative cells	Pasteurization
+65°	Multiplication of germs	Danger zone
+45°	Multiplication of germs	Prohibited zone
+20°	Multiplication of germs	Danger zone
+10°		
0°		Preservation
0°F = -18°	Germs multiplication stopped	Freezing

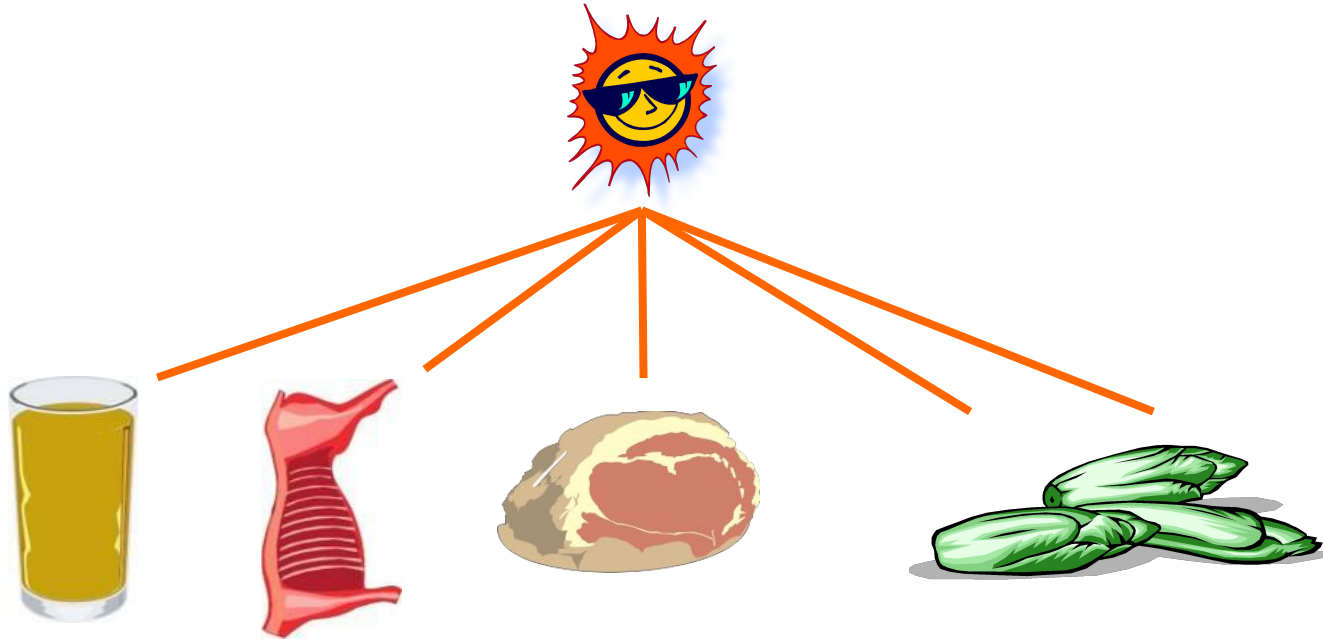
Impact of Humidity on Foods

Relative humidity



Growth of microorganisms

Impact of Light on Foods



- Oxidative rancidity
- Discoloration (e.g. ham)
- Adverse effect on nutritional value (e.g. vitamins)

So Let's review some medieval recipes

- Identify the food safety concept
- Identify the food preservation technique
- Look for “smart” ways of doing things to ensure safety

Danish Recipe Book Koge Bog 1616

Source: <http://forest.gen.nz/Medieval/articles/cooking/1616.html>

CAP.V. Om Kogen.

Hvad kogen anlanger/vil jeg først sætte her nogle stycker/som hoss oss i vore Lande brugelige ere. At Køckersken eller Kocken skal være reenførdig/oc holde sine Potter/Gryder/Kedle/Pander/oc andet rædskab/altid reenlig/gjøres der intet behoff at omtale/huer veed vel saadant selff: Thi om nogen Mad rædis oc kogis vdi en skiden Gryde eller Potte/om det vaar icke andet end en Søbekaal/da faar den strax en skiden oc ond smag der aff. Eller om mand seer en skiden Kockedreng eller Pige/tæncker huorledis den omgaar met Maden/rører der vdi/falder vel skarn aff Ermer i Gryden hand rører i/etc. da faar mand gierne en leede oc keedsommelighed til hans Mad/derfor bør alting her at være reenligt/giffue skarnet/Haar oc disslike paa eet Fad/oc beholde det selff: Men den reene Mad paa et andet/at frembære for got Folck. Saltmad/røget Flesk/Kiød/Tunge/Faarekrop/Gaasekrop at koge/veed vel huer/der om ville wi intet skriffue.

Translation: Chapter V. About cooking.

As far as cooking is concerned, I would first state a few things that are common in our lands. That the cook or [female cook] should be cleanly, and keep their pots, pans, containers, pans and other tools always clean, there is no need to tell, everyone knows this themselves. For if any food is made or cooked in a dirty pot or pan, even if it wasn't anything other than a cabbage, then it will immediately get a dirty and evil taste thereof. Or if you see a dirty cook's page or maid, imagine how they interact with the food, stirring it, their sleeve is bound to fall in the pot they are stirring, etc. then you are likely to feel unhappy and dislike their food, therefore everything here should be clean, give the dirt, hair and such on a tray and keep it themselves, but the clean food on another and serve it forth to good people. Salt food, smoked ham, meat, tongue, mutton, goose to cook surely everyone knows how to cook, thereof we will write nothing.

So Let's Identify the Modern Food Safety Concepts

Source: <http://forest.gen.nz/Medieval/articles/cooking/1616.html>

Translation: Chapter V. About cooking.

As far as cooking is concerned, I would first state a few things that are common in our lands. That the cook or [female cook] should be cleanly, and keep their pots, pans, containers, pans and other tools always clean, there is no need to tell, everyone knows this themselves. For if any food is made or cooked in a dirty pot or pan, even if it wasn't anything other than a cabbage, then it will immediately get a dirty and evil taste thereof. Or if you see a dirty cook's page or maid, imagine how they interact with the food, stirring it, their sleeve is bound to fall in the pot they are stirring, etc. then you are likely to feel unhappy and dislike their food, therefore everything here should be clean, give the dirt, hair and such on a tray and keep it themselves, but the clean food on another and serve it forth to good people. Salt food, smoked ham, meat, tongue, mutton, goose to cook surely everyone knows how to cook, thereof we will write nothing.

- Hygiene of pots, pans, and tools
 - Note the “get a dirty and evil taste”
- Hygiene of worker
 - Sleeve in pot
 - Hair to themselves

Another one from Koge Bog 1616, Concepts?

Source: <http://forest.gen.nz/Medieval/articles/cooking/1616.html>

Translation: XII. Lambs' heads to keep through the winter.

Seethe the lambs' heads and then clean them, and rub them well with Luneburg salt [rock salt]. Put them properly in a container so that the meaty sides are turned to each other, and sprinkle Luneburg salt thinly thereover so that the salt can be absorbed overnight. Then make of bay salt [sea salt] a solution so that an egg can float therein. Seeth the same solution and pour it over, then put over a [board/lid] with slight weight that can hold them down. This way you can keep feet, [callune], big intestines, liver and heart of lamb and others fresh of Beef. When you want to use it, then put it one day and night in fresh water and replace the water a few times. Then fry it.

- Use of Salt to reduce the water activity
- Note the use of a egg to determine the salt concentration
 - No weights/measure
 - Egg provides method of Specific Gravity or density - which gives us a constant concentration
- Technique: Salting

Another one from Koge Bog 1616, Concepts?

Source: <http://forest.gen.nz/Medieval/articles/cooking/1616.html>

Translation: XVIII. Goose game to keep

Take goose game which is boiled up with herbs, but not too soft. Put it together in a clay pot, and pour over fresh lamb's tallow, thus it can be kept undamaged through the winter and longer.

Take care as soon as something is taken of it that it shall be used soon after the hand is used, because otherwise it spoils.

Wherefore one usually only has one or two servings in each pot, of which one can have use. In the same way you treat puffin.

- Herbs -some have antimicrobial properties too (I'm still collecting data)
- Use of lamb's tallow makes a seal
 - Similar to modern Modified Atmosphere Packaging
- Reduce size of package to what you will use in a few servings
 - Acknowledge issues with product after "unsealing it"
- Technique: Larding

Another one from Koge Bog 1616, Concepts?

Source: <http://forest.gen.nz/Medieval/articles/cooking/1616.html>

Translation: XXII. To cure Salmon.

Cut the back out of a fresh salmon. Put the same salmon into a trough and spread it on both sides with blood on the places the back is cut off. Thereafter pour salt over and under the salmon. Let him lie in it for two or three nights depending on how thick and big it is. Then he is hung in a room where the wind can blow in both sides and the sun in the meantime can shine. When the salmon has hung some time and you notice the fat falling to the one end that's down, then you should turn it upside down. Because if quickly smoked the salmon soon isn't good.

- Use of Salt to reduce the water activity for 2 to 3 days
- Hung in a room where the wind can blow both sides
 - Indoors.. Minimize impact of insect activity
- Fat falling down
 - Critical to remove for rancidity... acknowledging that it is a problem
- Techniques: Salting, Drying

Le Menagier de Paris 1393 (Translation) Concepts?

Source: <http://www.daviddfriedman.com/Medieval/Cookbooks/Menagier/Menagier.html>

Translation:

Note that some hang their pigs in the Easter season and the air yellows them; and it would be better for them to keep them in salt as they do in Picardy, even though the flesh is not so firm, it seems; nevertheless you get better service from bacon which is fair and white than from yellow, because however good the yellow may be, it is too repulsive and causes disgust when viewed[53].

- Air cause it to “yellow”
 - Most likely “light” as we discussed
 - In Easter Season indicates “cold weather” - chilling/freezing?
- Use of salt
 - Reduction in water activity
- Bacon - which is cured
 - Better shelf life acknowledged
 - Warning about when bacon not good - when fat turns yellow (rancidity)
- Comparison of the three techniques:
 - Fresh/Freezing?, Larding, Curing

Le Menagier de Paris 1393 (Translation) Concepts?

Source: <http://www.daviddfriedman.com/Medieval/Cookbooks/Menagier/Menagier.html>

Translation:

To Make Candied Orange Peel, divide the peel of one orange into five quarters and scrape with a knife to remove the white part inside, then put them to soak in good sweet water for nine days, and change the water every day; then cook them in good water just till boiling, and when this happens, spread them on a cloth and let them get thoroughly dry, then put them in a pot with enough honey to cover them, and boil on a low fire and skim, and when you believe the honey is cooked, (to test if it is cooked, have some water in a bowl, and let drip into this one drop of the honey, and if it spreads, it is not cooked; and if the drop of honey holds together in the water without spreading out, it is cooked;) and then you must remove your orange peel, and make one layer with it, and sprinkle with ginger powder, then another layer, and sprinkle etc., and so on; and leave it a month or more, then eat.

- Use of honey and sweet water(sugar)
 - Reduce water activity
- Pasteurization
 - “Cook them in good water just til boiling”
 - Cooking in honey until soft ball stage
- Spice Usage
 - Ginger is one of our anti-microbial spices
- Shelf life indicated
 - “Leave it for month or more”
- Techniques: Pasteurization, Candying

Ouverture de Cuisine (Translation) Concepts?

Source: <http://www.medievalcooking.com/notes/ouverture.html>

Translation: To make Bologna sausage.

Take six pounds of slightly fatty pork, & cut into slices, & put in a cloth, put it in a press to squeeze out the blood, & let sit one hour in the press until the blood is all out, then chop it coarsely, not too small, put therein four ounces of salt, an ounce of pepper, grind coarsely, one ounce of cinnamon well powdered with a fine sieve, & mix all together with the salt, & put into the meat, & take eight ounces of Spanish wine, & mix it well by hand for a half hour, when all will be incorporated into the meat, then take beef intestines that are thicker than you want the sausage, then fill with the meat as hard as possible, & have a thick eplingue at hand for always piercing the intestine, at the end that doesn't have any hole therein, & that the meat will be well compacted, then tie the intestine well closed thereon & thereon of the length that you want to have the sausage, then have a cauldron of boiling water on the fire, & put to boil the sausages in three or four boilings, & cut them apart, then hang them at the chimney five or six days until they are well dried.

- Selection of “slightly fatty pork”
 - Reduce fat load into process to reduce rancidity
- Use of salt
 - Salt at this time also had nitrates and again water activity
- Spice Usage
 - Cinnamon and Pepper.
- Minimize oxygen retention in casing
 - Packed hard to minimize issues
- Boiling/Pasteurization prior to Smoking
- Techniques: Prep - Salting, Spices, Packaging, Pasteurization, Smoking

Ouverture de Cuisine (Translation) Concepts?

Source: <http://www.medievalcooking.com/notes/ouverture.html>

Translation: To make Bologna sausage.

Take six pounds of slightly fatty pork, & cut into slices, & put in a cloth, put it in a press to squeeze out the blood, & let sit one hour in the press until the blood is all out, then chop it coarsely, not too small, put therein four ounces of salt, an ounce of pepper, grind coarsely, one ounce of cinnamon well powdered with a fine sieve, & mix all together with the salt, & put into the meat, & take eight ounces of Spanish wine, & mix it well by hand for a half hour, when all will be incorporated into the meat, then take beef intestines that are thicker than you want the sausage, then fill with the meat as hard as possible, & have a thick eplingue at hand for always piercing the intestine, at the end that doesn't have any hole therein, & that the meat will be well compacted, then tie the intestine well closed thereon & thereon of the length that you want to have the sausage, then have a cauldron of boiling water on the fire, & put to boil the sausages in three or four boilings, & cut them apart, then hang them at the chimney five or six days until they are well dried.

- Selection of “slightly fatty pork”
 - Reduce fat load into process to reduce rancidity
- Use of salt
 - Salt at this time also had nitrates and again water activity
- Spice Usage
 - Cinnamon and Pepper are anti-microbials
- Wine to reduce pH
 - Helps with antimicrobial and provide marinate
- Minimize oxygen retention in casing
 - Packed hard to minimize issues
- Boiling/Pasteurization prior to Smoking
- Techniques: Prep - Salting, Spices, pH Reduction, Packaging, Pasteurization, Smoking

Ouverture de Cuisine (Translation) Concepts?

Source: <http://www.medievalcookery.com/notes/ouverture.html>

Translation: To keep cucumbers.

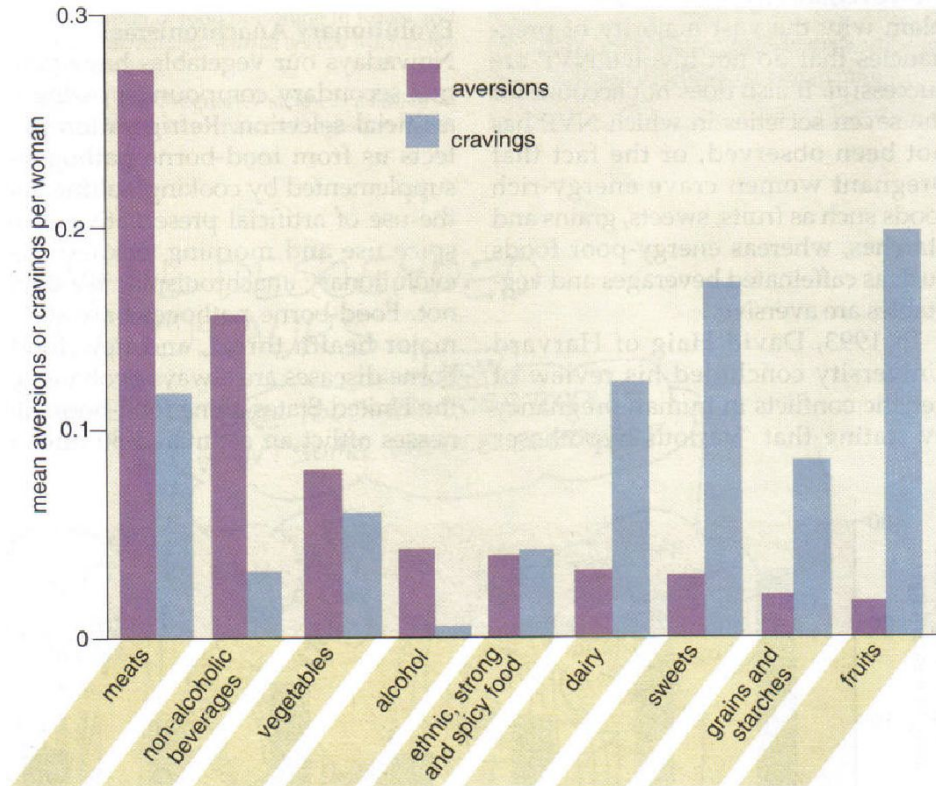
Take little cucumbers, & let them rest on a table to sweat three or four days, then take vinegar & make them boil, & skim, & let cool, then cast the cucumbers therein, and leave them so five days or three weeks, then cast the vinegar out, and take more vinegar boiled and skimmed, and let cool, then cast it on the cucumbers and put ground alum therein, and take the seed of fennel that is somewhat ripe, & cast into the cask that it will be well layered, & keep it so.

- Let them sweat
 - Vegetables and Fruits lose moisture through “transpiration” which provides a drier surface to accept the salt solution
- Vinegar and Pasteurization
 - pH Reduction, antimicrobial
- Potassium Aluminum Sulphate (Alum)
 - Approved by Health Canada as a permitted food firming agent
- Fennel
 - Some microbiological inhibition research out there... I still need to review it vs vegetable pathogens
- Techniques: Prep, pH reduction, firming agent, spice microbial inhibition?, bottling

Let's Stop.. Wait.. didn't people eat Rotten Meat?

- We have found that most of these recipes include good food practices and processes
 - So if they have good practices... is this idea really true?
- Let's review Sherman, Paul W., and Samuel M. Flaxman. "Food, Protecting Ourselves from Food." American Scientist 89 (March-April 2001) paper
 - Reviewed "20 studies of food aversions among 5432 women and 21 studies of food cravings (among 6239 women) which were based on questionnaires administered to women during pregnancy or soon after" delivery.

Aversions and Cravings of Pregnant Women



- Concluded that the “three most averse food categories that were the ones most likely to contain microorganisms (meat products) and phytochemicals (vegetable, coffee and tea).
- Further explained “In contrast, the food categories that were most often craved than found aversive (fruits, grains, sweets and dairy products) were the ones least likely to contain microorganisms or phytochemicals”

Sherman and Flaxman (2001)

- The “pickiness” of children and first trimester pregnant women suggested that meat avoidance supported the evolutionary theory that we choose not to consume food that could cause microbiological issues during high cell development.
- Supported the rejection of the “cover up” hypothesis that medieval people used spices to disguise foul smells and tastes of spoiled food. (Sherman and Hash 2001)
- Since both at-risk populations (children and pregnant women) avoid meat sources, most likely the common person would make the evolutionary choice not to consume bad tasting meat dishes.

Medieval People Made Logical Decisions!

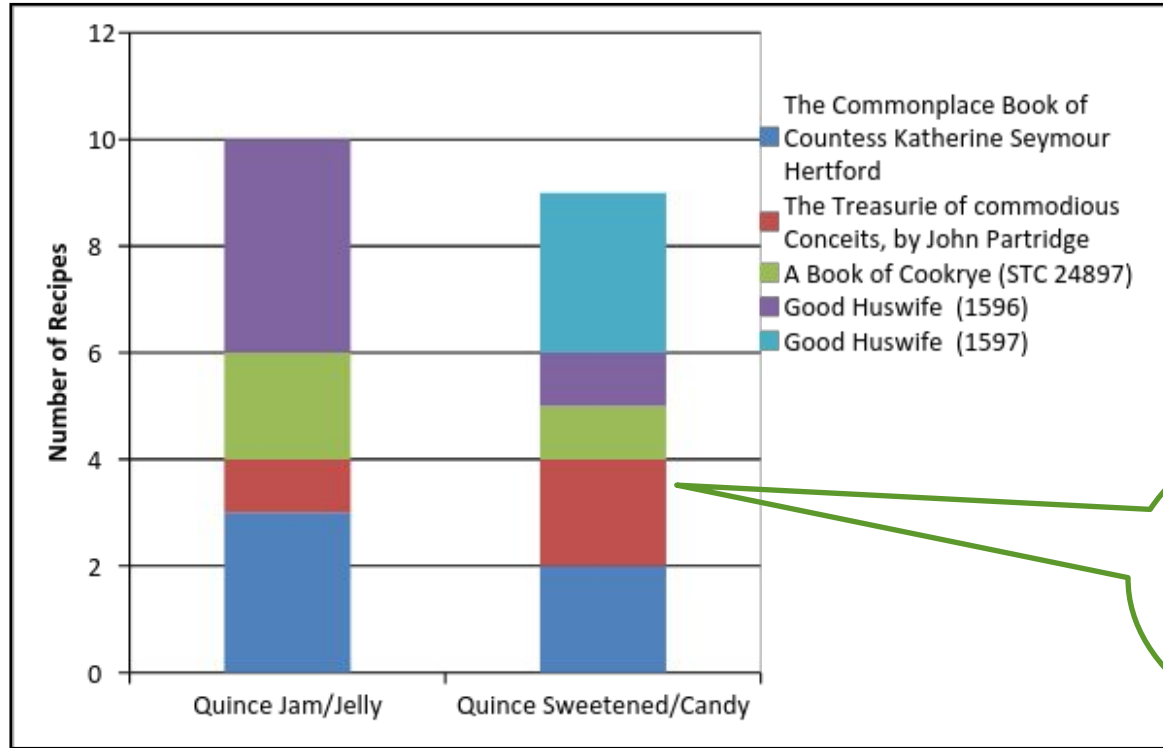
- Let's look at quince preservation.. Another topic of one of my research papers
- Specifically, let's discuss:
 - Recipe Analysis
 - Potential techniques for preservation
 - Which ones can work or not work
 - Taste and Texture Survey for the potential ones
 - Show that logical methods were used
- First.. What's a quince?

Quinces and Its Importance



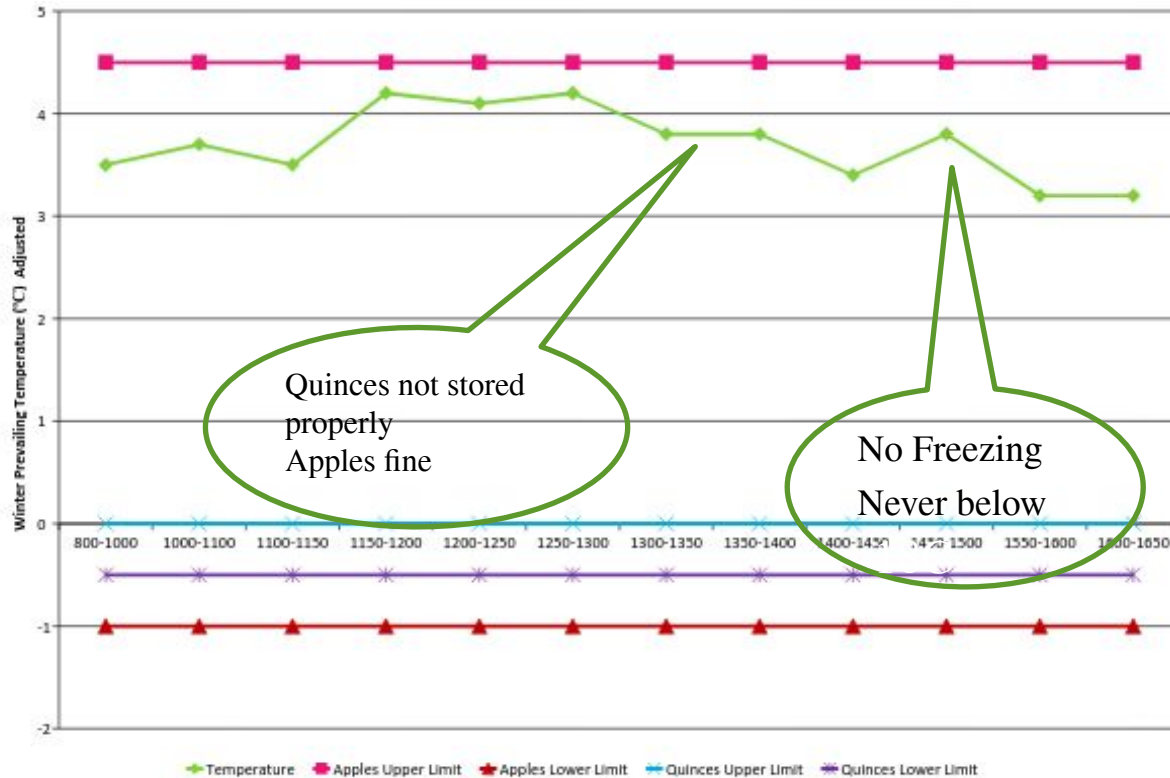
- Description: Bright Yellow, 7-12cm long, 6-9cm wide
- Family/Genus: Rosaceae/Cydonia
- Native to: Iran and Turkey
- Cultivated in: India, South Africa, Middle East and Europe
- Nutritional: Similar to apples, high in Vitamin C, Calcium and Potassium

Recipe Analysis

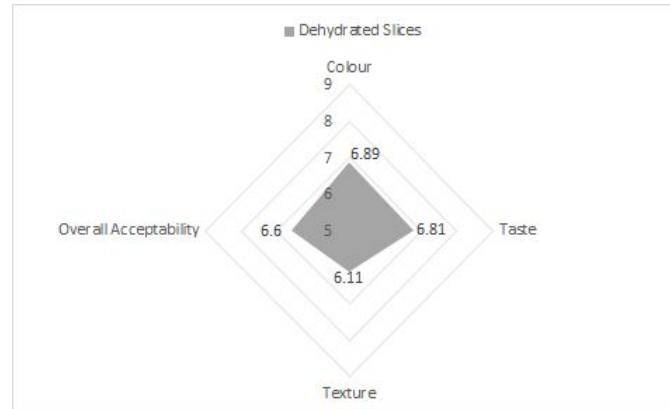
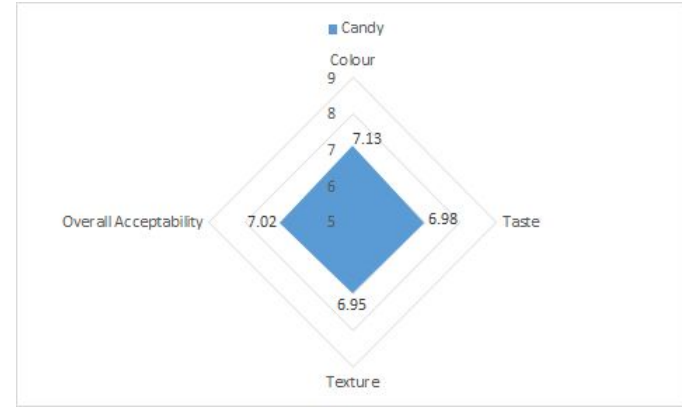
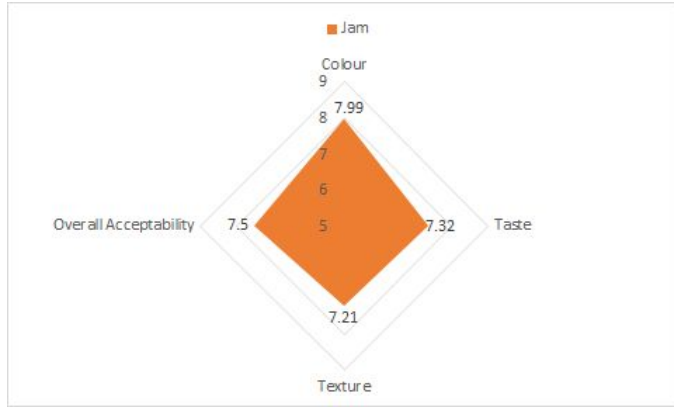


Only Two Methods Used.. Why nothing else?

Why no Freezing or Cold Storage (like Apples)?



So we are left with Jam, Candy and Dehydration



Based on these.. Jam over candy over dehydrated slices.

Very little dehydrated papers exist even now.

Conclusions

- Evolutionary choices were developed to help with food safety
- We choose not to consume things that don't make us sick
- Spices are not used to cover up rotten meat
- Salting, drying etc directly relate to a modern food safety concept of water activity
- Other factors like taste, texture and colour affect how people perceive food and hence choices