

What Happens When You Lower Salt In Cheese

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Dietary Guidelines leading into 2010

- **Sodium consumption should be lowered**
 - *2700 to 4900 mg: commonly consumed daily*
 - *2300 mg: US Dietary Reference intake, adults, 2005*
 - *2300 mg: Upper Tolerable Limit (for blood pressure)*
 - *1500 mg: Adequate Intake*

(Adults)

National Salt Reduction Initiative

	Sodium mg/100g	Baseline 2009	2012 Target	2014 Target	25% Reduced Sodium
Cheddar	649*	668	630	600	465
Mozzarella	688*	668	630	600	398
Cottage	330* *	347	330	290	143
Process	688*	1393	1250	1040	398

*Label value for sodium from DMI study 2009-2010

Agarwal et al. 2011. J. Dairy Sci. 94 :1605–1615

**Analytical value from USDA food composition database

<http://www.nal.usda.gov/fnic/foodcomp/search/>

2010 Dietary Guidelines

- **Key Recommendation**

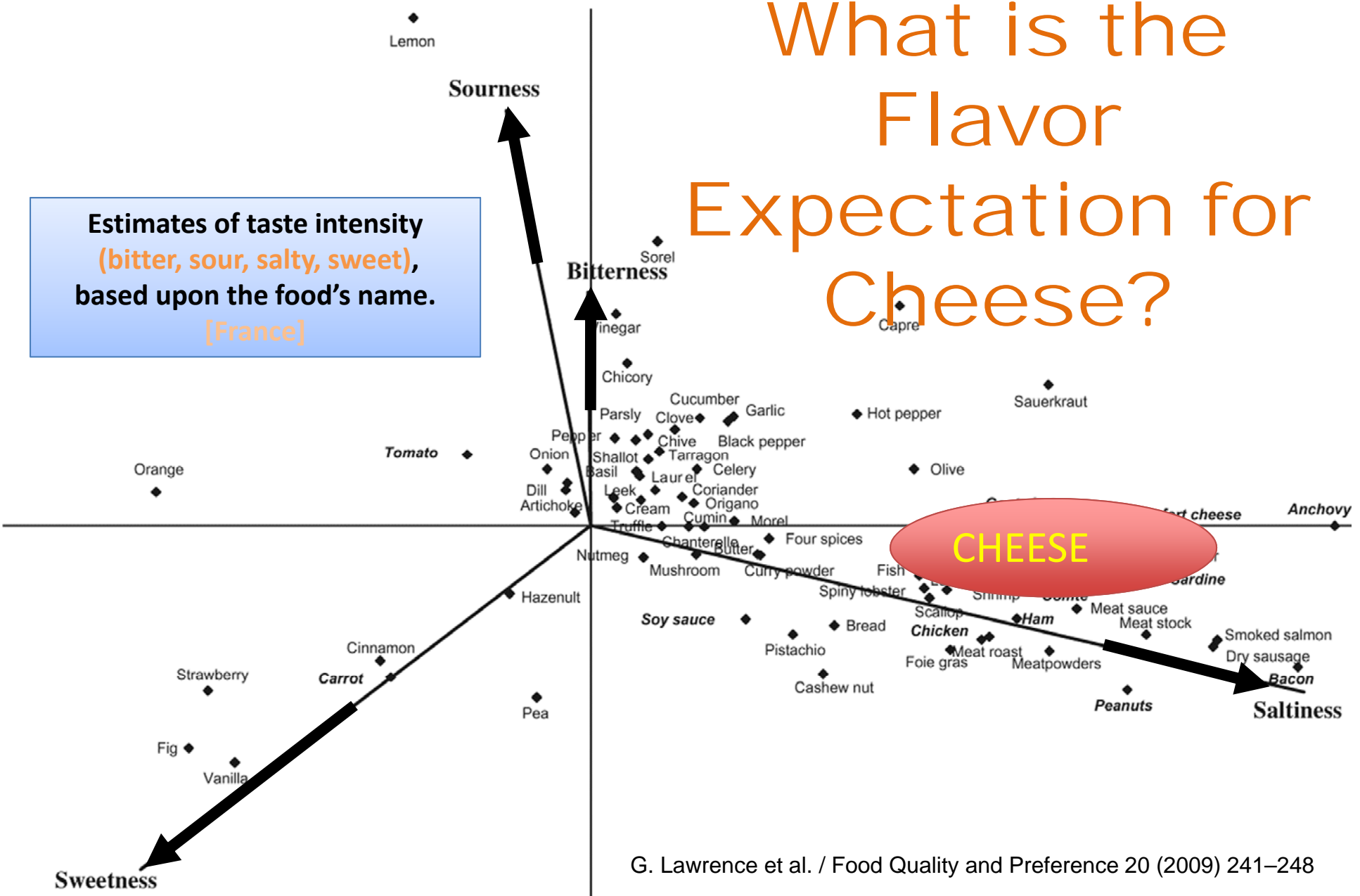
“Reduce daily sodium intake to less than 2,300 milligrams (mg) and further reduce intake to 1,500 mg among persons who are 51 and older and those of any age who are African American or have hypertension, diabetes, or chronic kidney disease. The 1,500 mg recommendation applies to about half of the U.S. population, including children, and the majority of adults.”

Problem?

- **Saltiness is an expected component of the taste of most cheeses**

What is the Flavor Expectation for Cheese?

Estimates of taste intensity (bitter, sour, salty, sweet), based upon the food's name. [France]



G. Lawrence et al. / Food Quality and Preference 20 (2009) 241–248

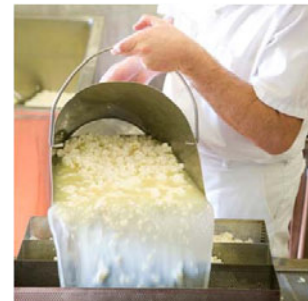
Salt plays multiple roles in Cheese Manufacture



- **Promotes moisture expulsion**
- **Controls survival of starter bacteria**
- **Inhibits survival of pathogenic bacteria**
- **Influences cheese texture & performance**
- **Controls enzyme activity**
- **Influences flavor production during aging**

Salt in Cheddar Cheese

- **Best aged Cheddar**
 - between 1.4% and 2.0% salt
 - 4% to 6% salt-in-moisture
- **Reducing salt below 1.4%**
 - Increases
 - bitterness, acidity, unpleasant aftertaste,
 - Decreases saltiness
- **Salty taste preferred**
 - cheddar cheese with 1.5% salt preferred over cheddar cheese with 1.25% salt



However, lower salt cheeses also higher moisture !

J. Dairy Sci: Lawrence and others, 1984; Schroeder and others, 1988; Mistry & Kasperson, 1998; Lindsay and others, 1982.

Previous Research

Salt in Cottage Cheese

- Cottage cheese contains about 3.3 mg sodium per gram
- 97% of sodium is from cream dressing
 - *Of the sodium in milk*
 - 57% → whey
 - 40% → wash water
 - 3% → curd
- Curd contains about 0.1 mg Na per gram

*USDA Food Composition Database
Wong et al., 1976 J Dairy Sci 59:41*

Substituting Potassium Chloride

- **Cottage cheese made with 1.26% salt as either**
 - ***100:0, 75:25 and 50:50 mixtures of***
 - **sodium chloride and potassium chloride**

% Potassium	Sodium (mg/g)	Flavor Score	Flavor Score
0%	5.5	5.48	5.80
25%	3.8	5.76	5.66
50%	2.7	5.45	5.11

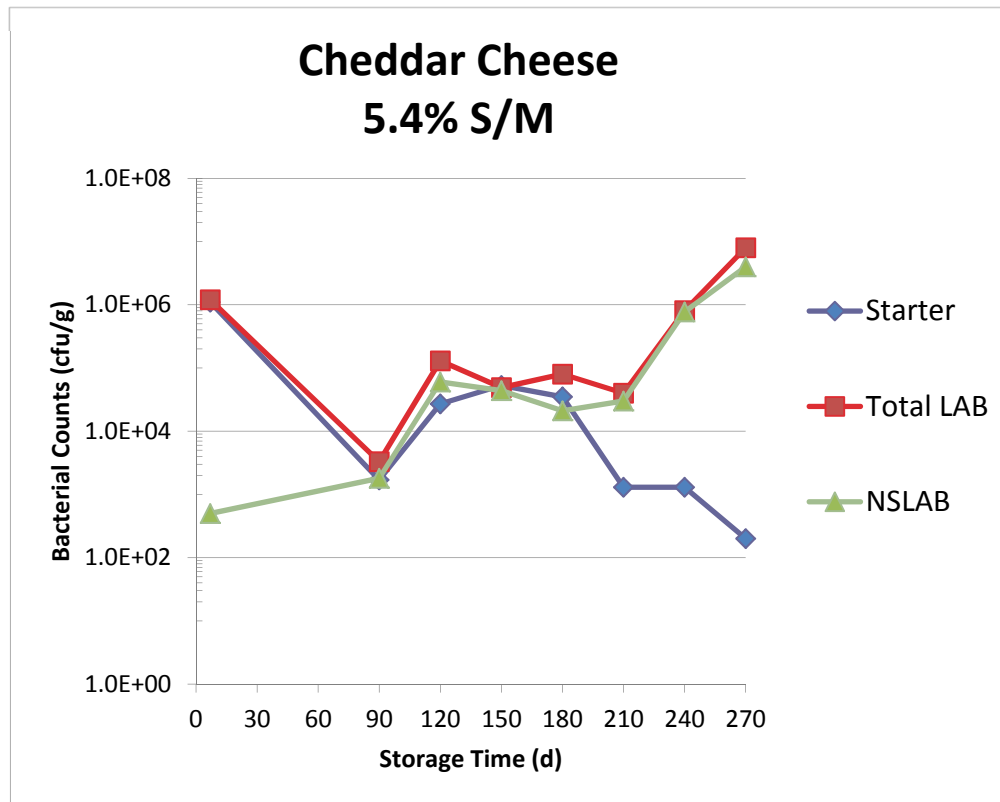
1 = dislike extremely 8 = like extremely

Demott et al, 1984 J Dairy Sci 67:1539

Salt and Cheese Microflora

Microbial Populations in Cheese

Normal Salt Level



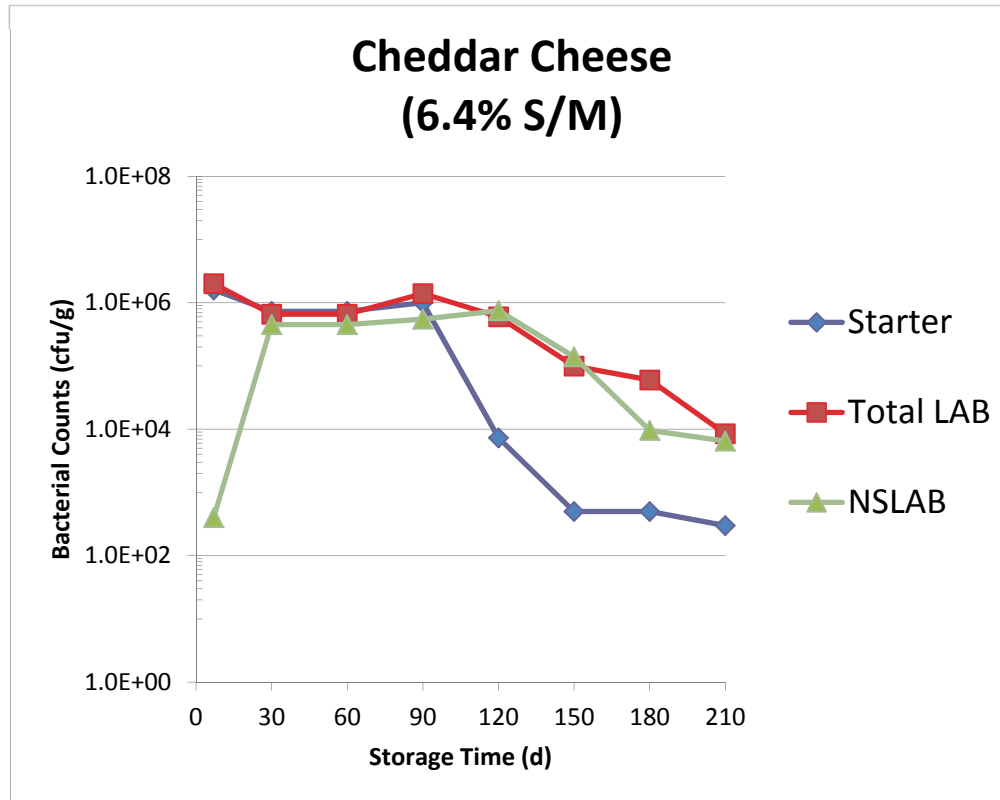
- **Starter cultures die off during storage at 42° F**
- **Nonstarter lactic acid bacteria slowly increase, dominate and grow to high levels.**

NSLAB = Nonstarter Lactic Acid Bacteria

S/M = salt concentration in the moisture phase of cheese

Microbial Populations in Cheese

High Salt Level



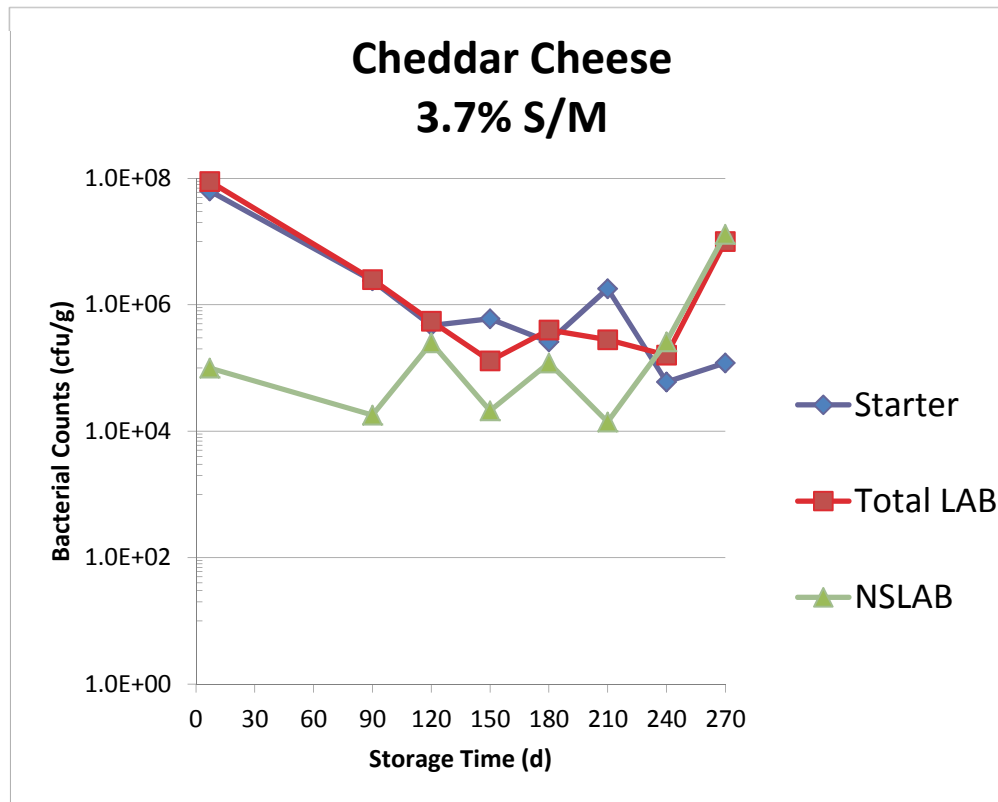
- **Starter culture bacteria die off**
- **NSLAB grow but are suppressed by high salt level**
- **Typically flavor develops more slowly**

NSLAB = Nonstarter Lactic Acid Bacteria

S/M = salt concentration in the moisture phase of cheese

Microbial Populations in Cheese

Low Salt Level

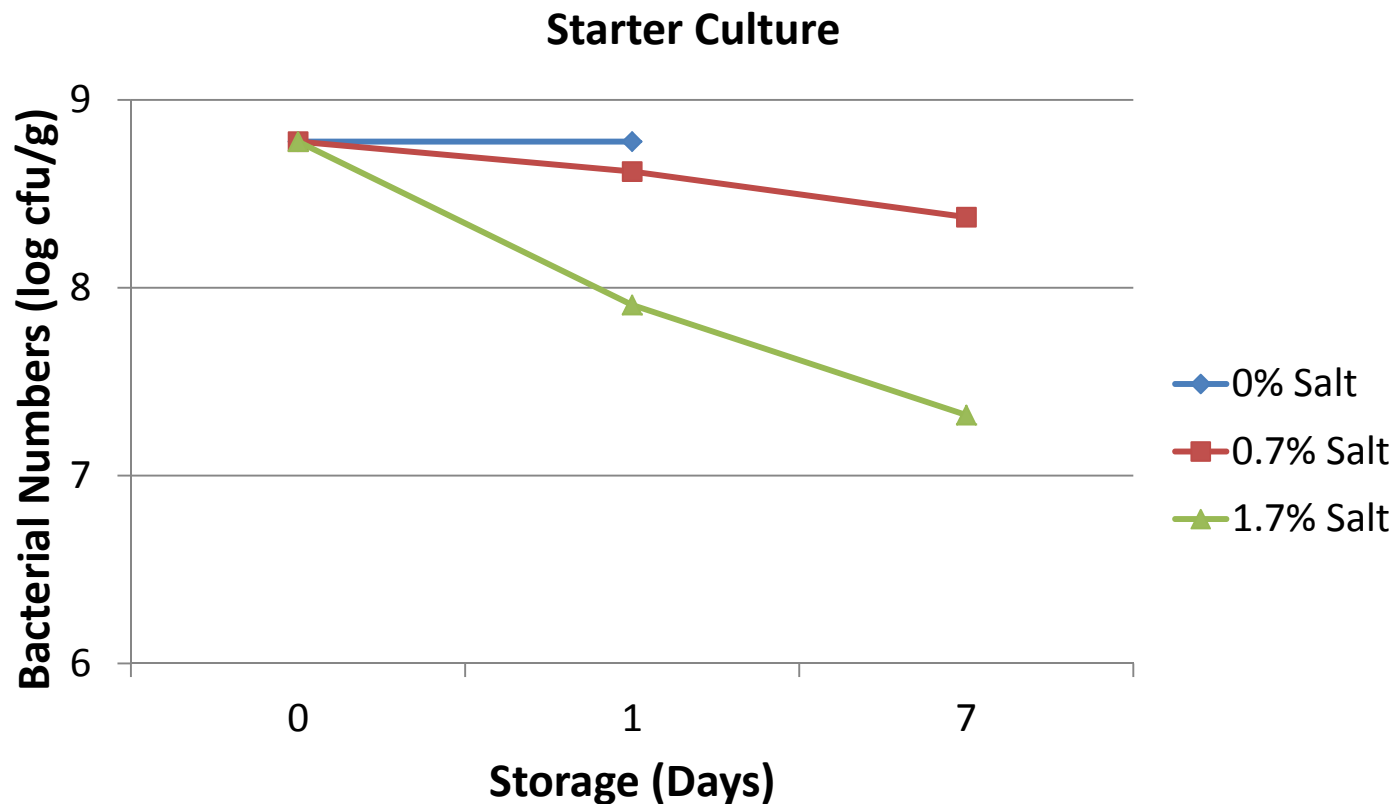


- **Starter culture bacteria remain at a high number for long time and compete with the NSLAB population**

NSLAB = Nonstarter Lactic Acid Bacteria

S/M = salt concentration in the moisture phase of cheese

Effect of Salt on Starter Culture



- **Lactococcus numbers stay higher during pressing and storage**

Salt and Cheese Flavor

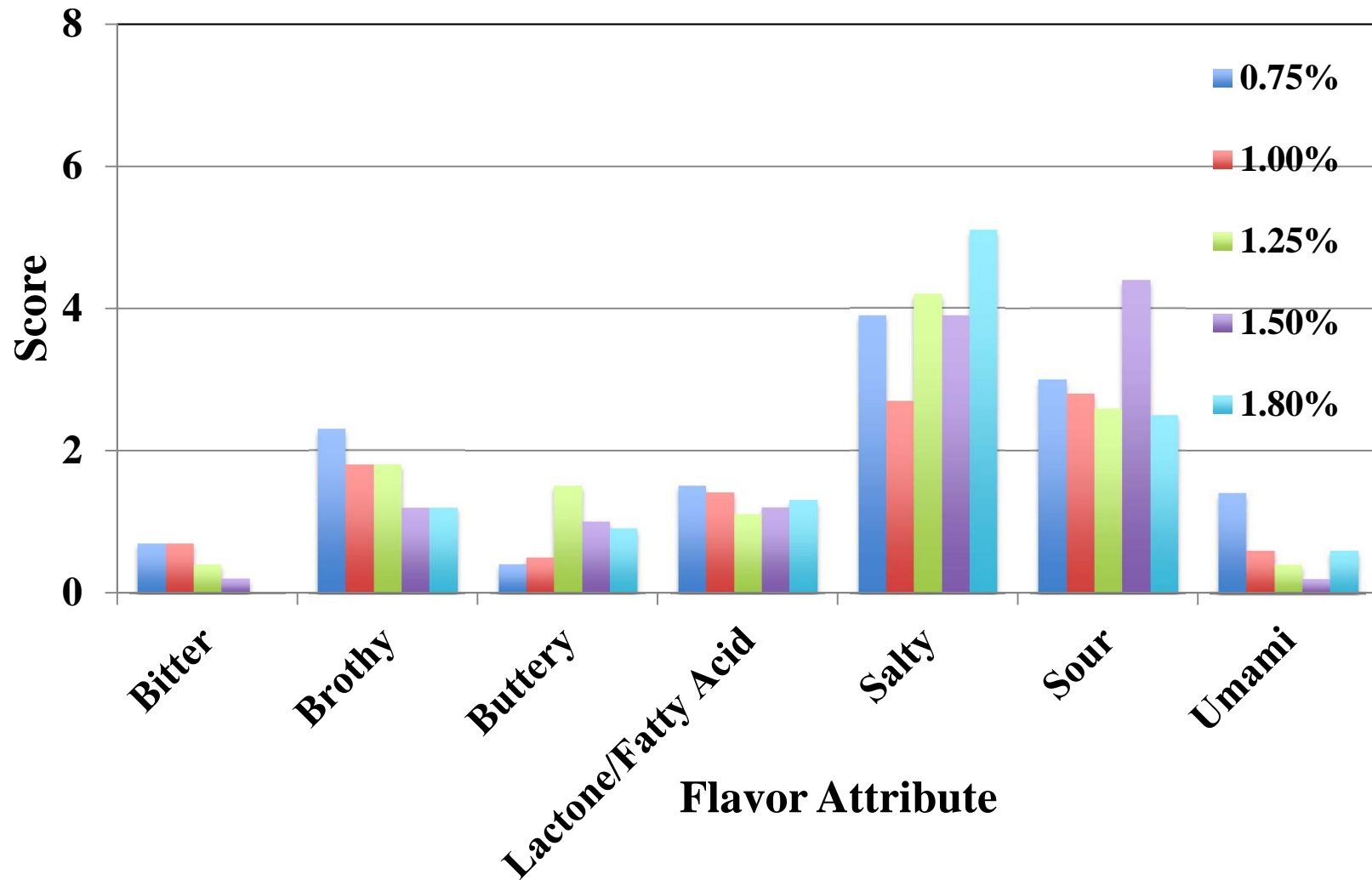
Cheddar

Lower Salt Cheddar

- **Manufacturing procedures varied to obtain lower salt levels while accounting for decreased whey expulsion after salting.**
- **No whey expulsion during salting with salting when salt level reduced 50%.**
- **Drier curd required before salting for lowest salt levels.**

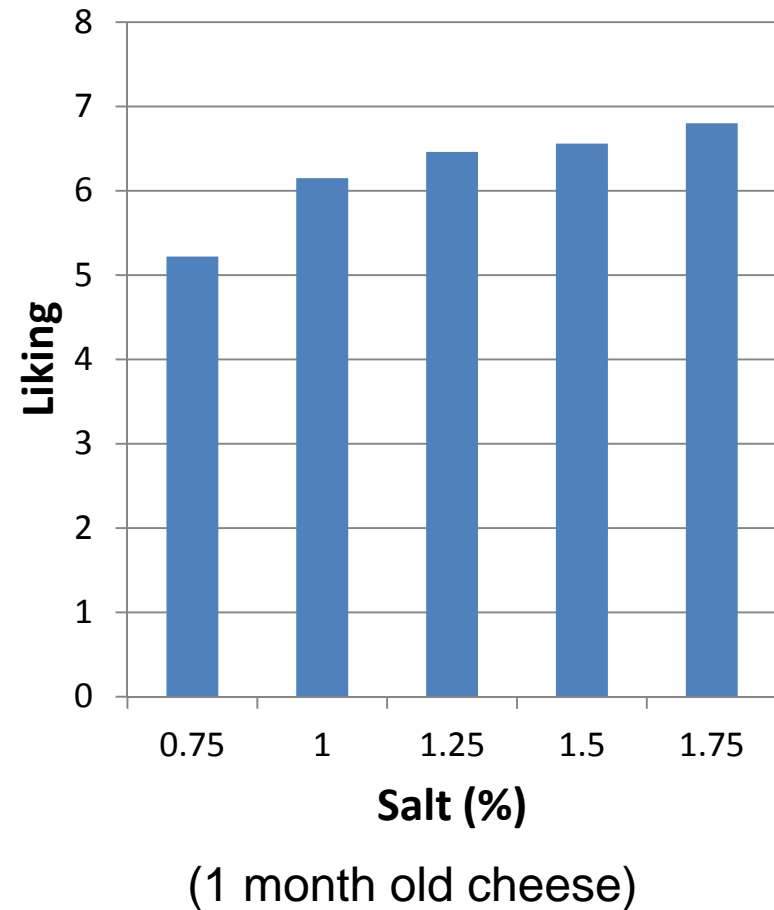
Moisture	36% to 39%
Fat	30% to 31%
pH	5.10 to 5.20

Flavor Attributes @ 1 month

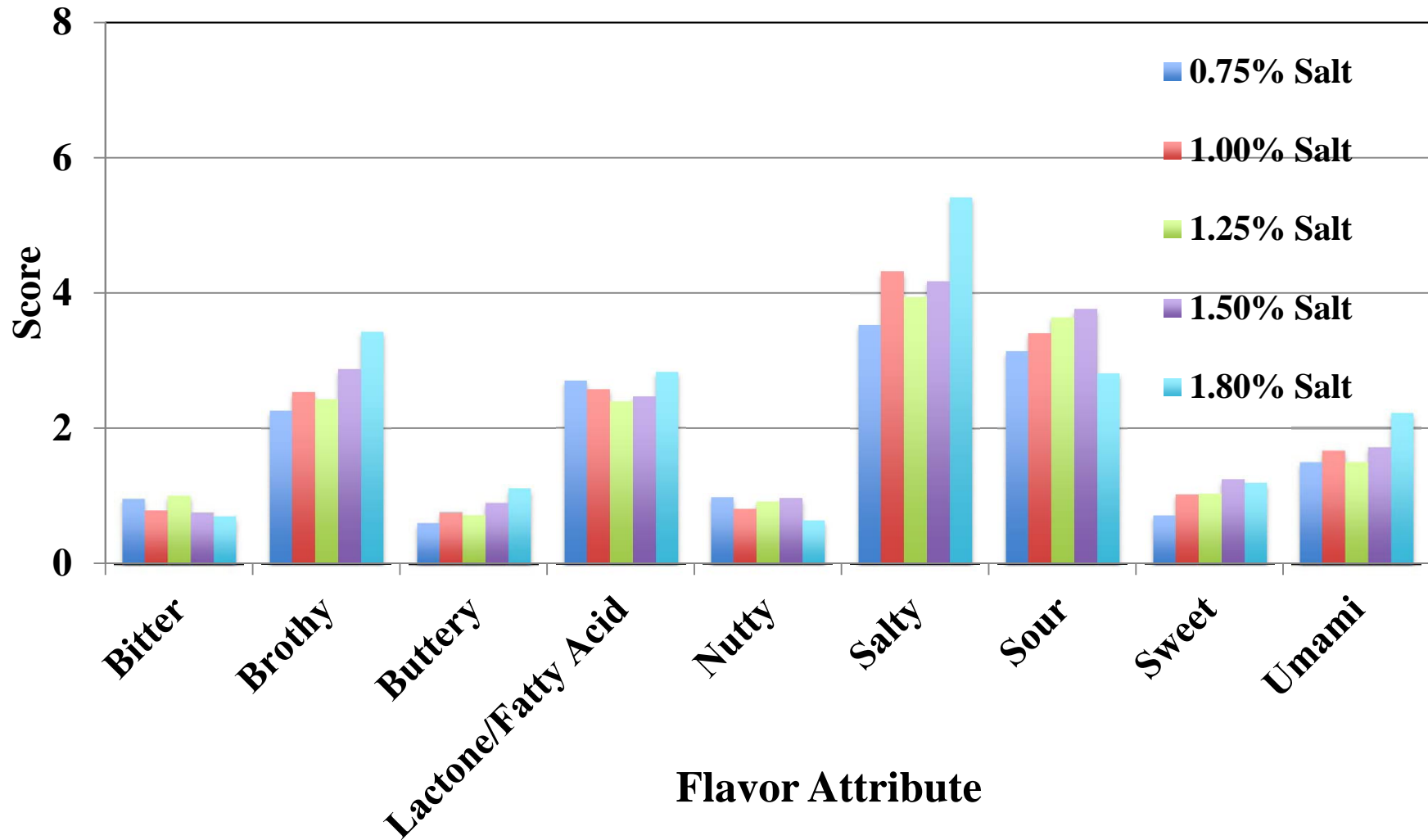


Consumer Response to Lowering Salt

- **Liking decrease with less salt.**
- **Some liking remains at 1% salt.**
 - *Cheddar cheese*
 - *similar moisture*
 - *similar pH*
 - **served cold**
 - **9-point hedonic scale**

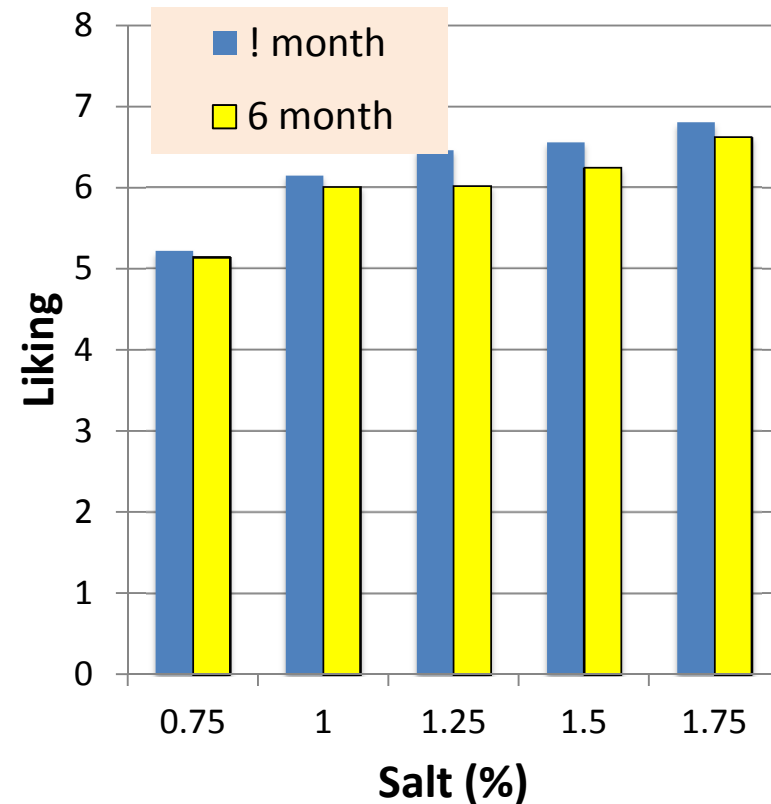


Flavor Attributes @ 6 month



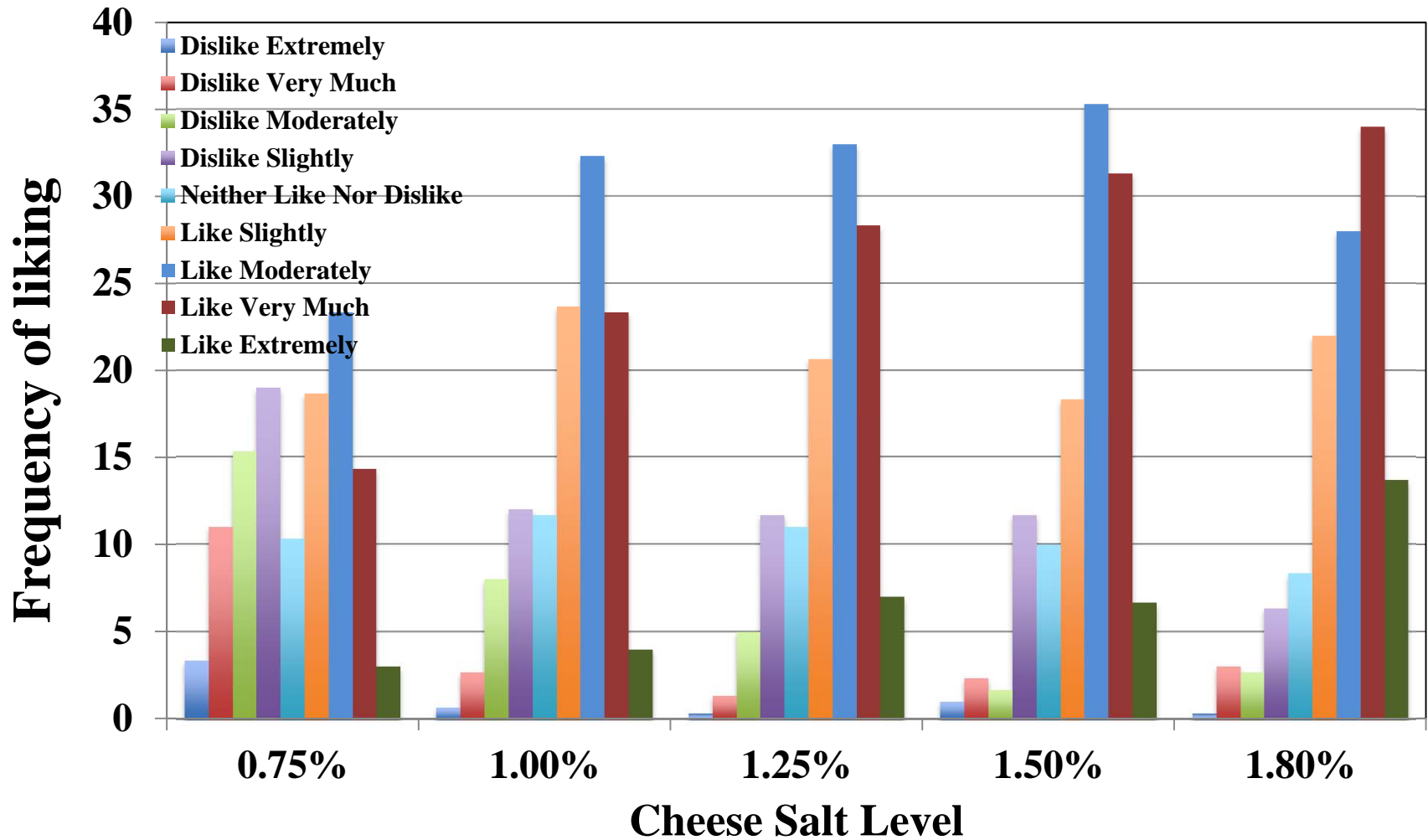
Consumer Response to Lowering Salt

- **Same trend for**
 - *mild (1 mo)*
 - *aged (6 mo)*
- **Overall mean score decreased, still slightly liked at 1% salt added.**

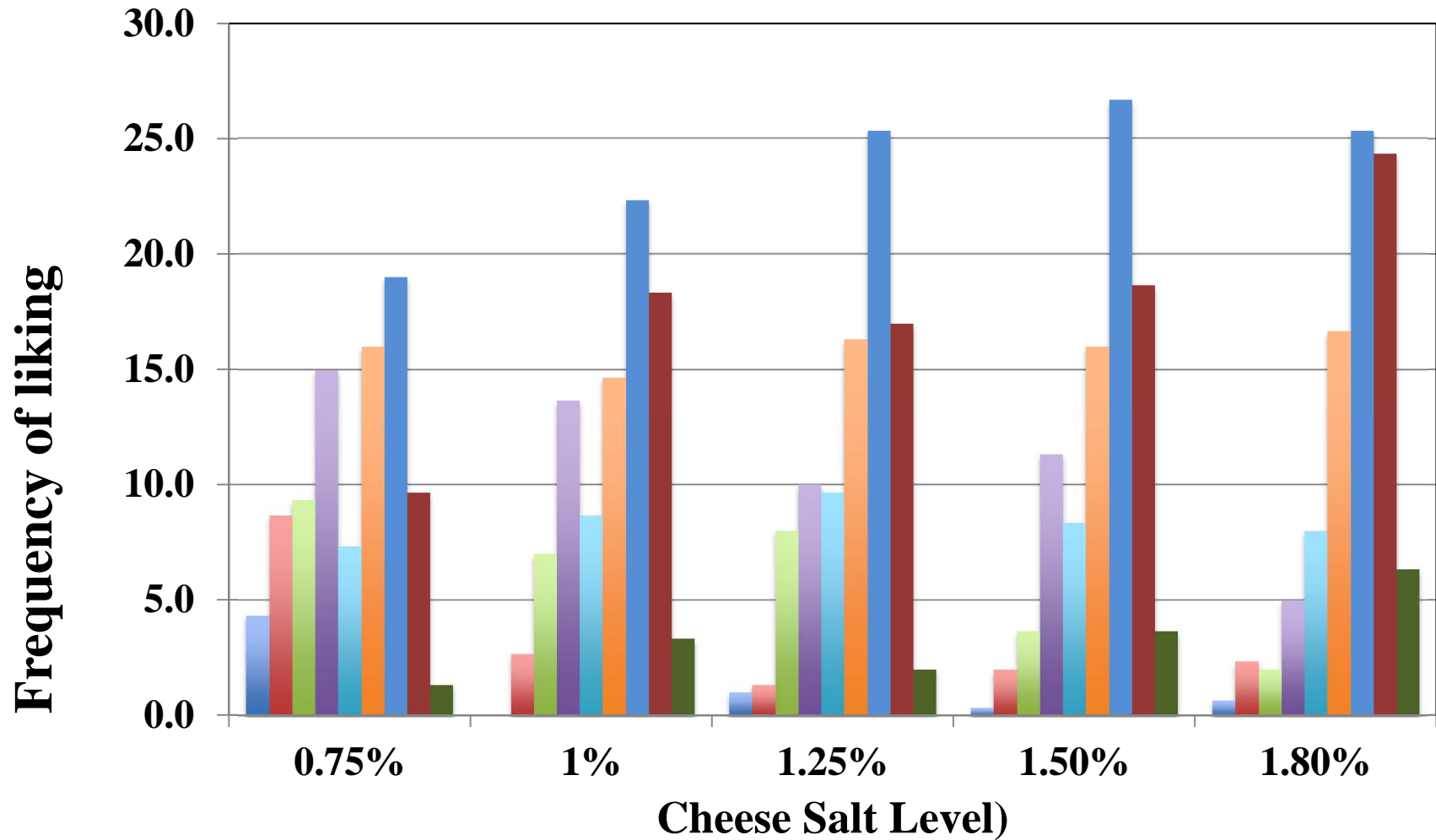


7 = like moderately
6 = like slightly
5 = neither like nor dislike

Flavor Scores @ 1 month



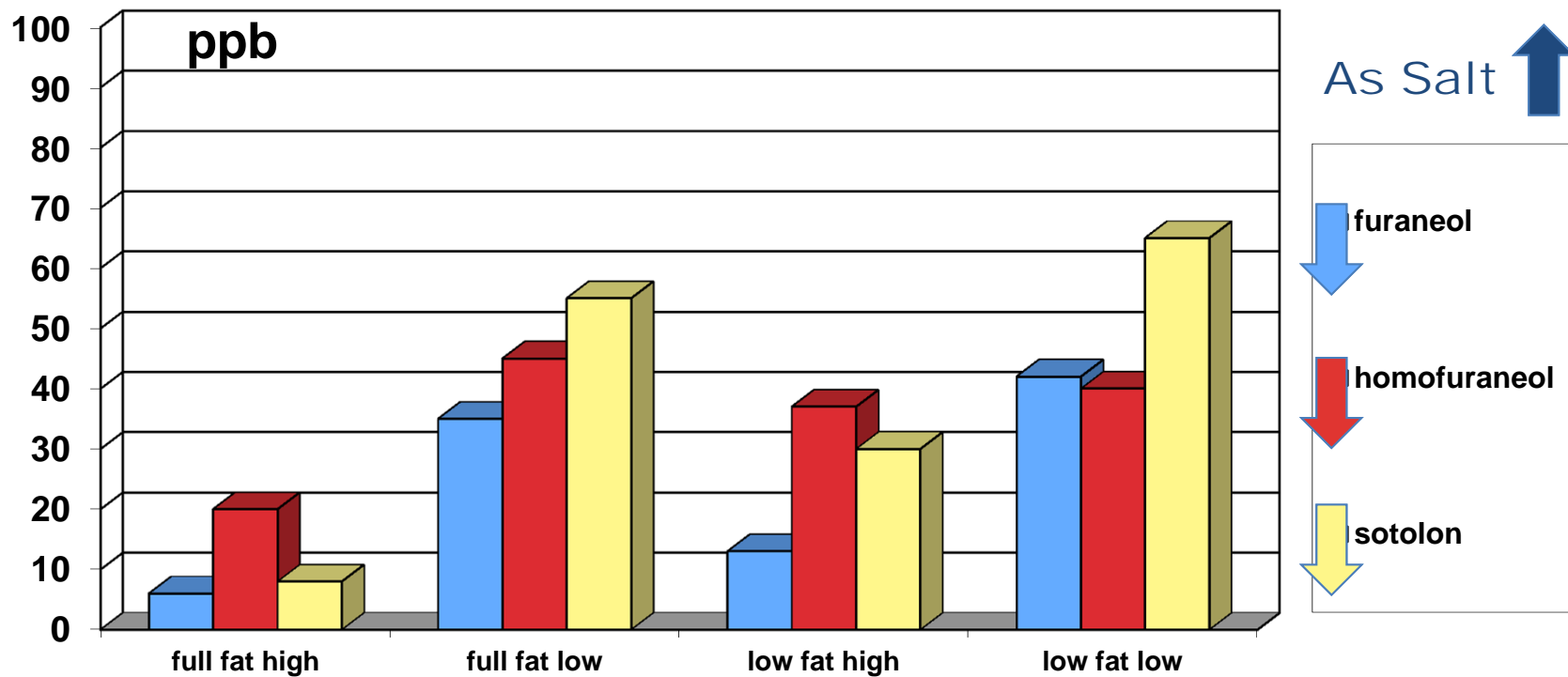
Flavor Scores @ 6 months



Flavor Chemistry

Salt and Cheddar Cheese

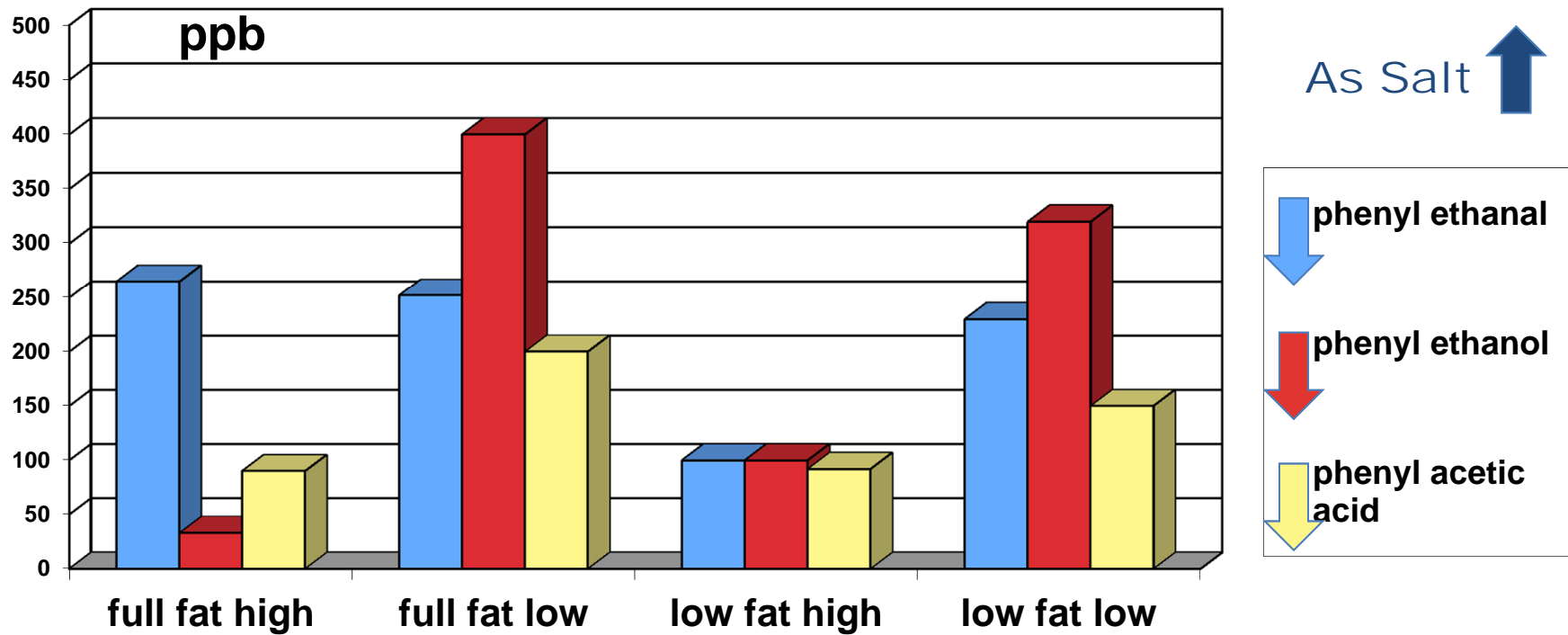
High 5.3% s/m (4.3% to 6.4%)
 Low 3.6% s/m (3.0% to 3.9%)
 Salt in Full Fat and Low Fat Cheese



8 mo ripening

MaryAnne Drake, NCSU

Salt Depresses Formation of Phenyl Compounds

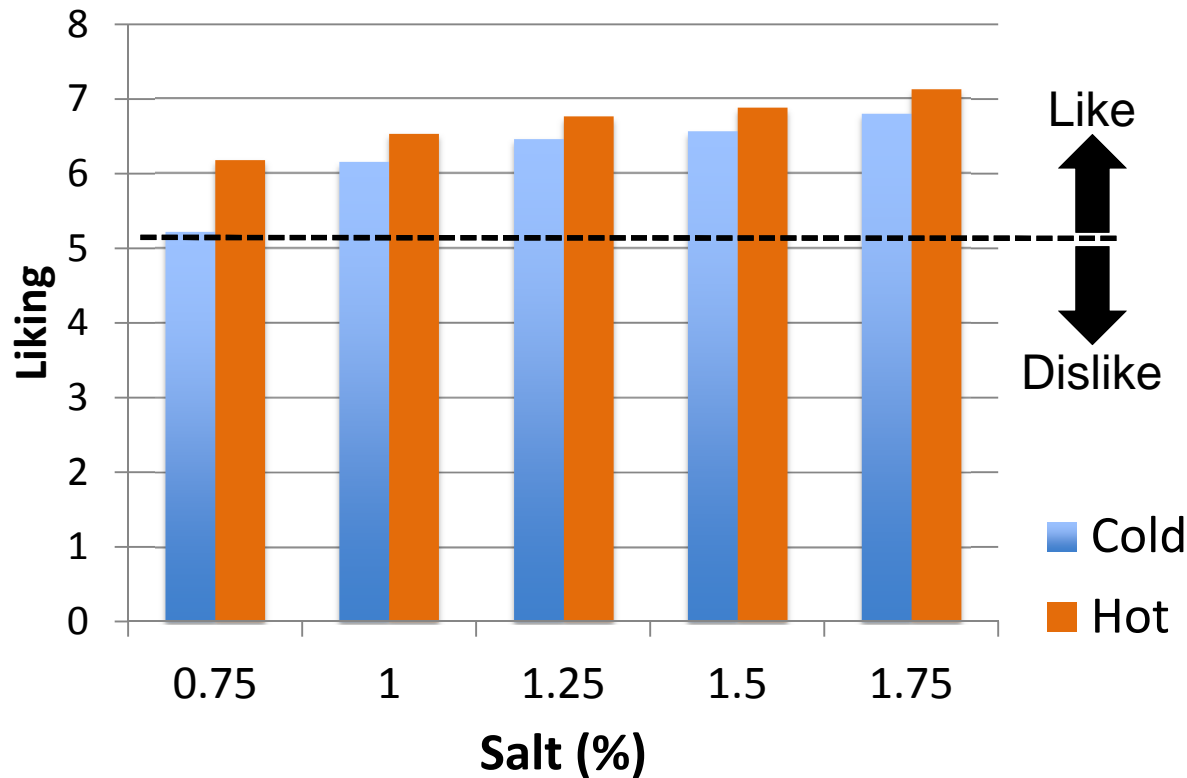


8 mo ripening

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Using Lower Salt Cheese in Foods

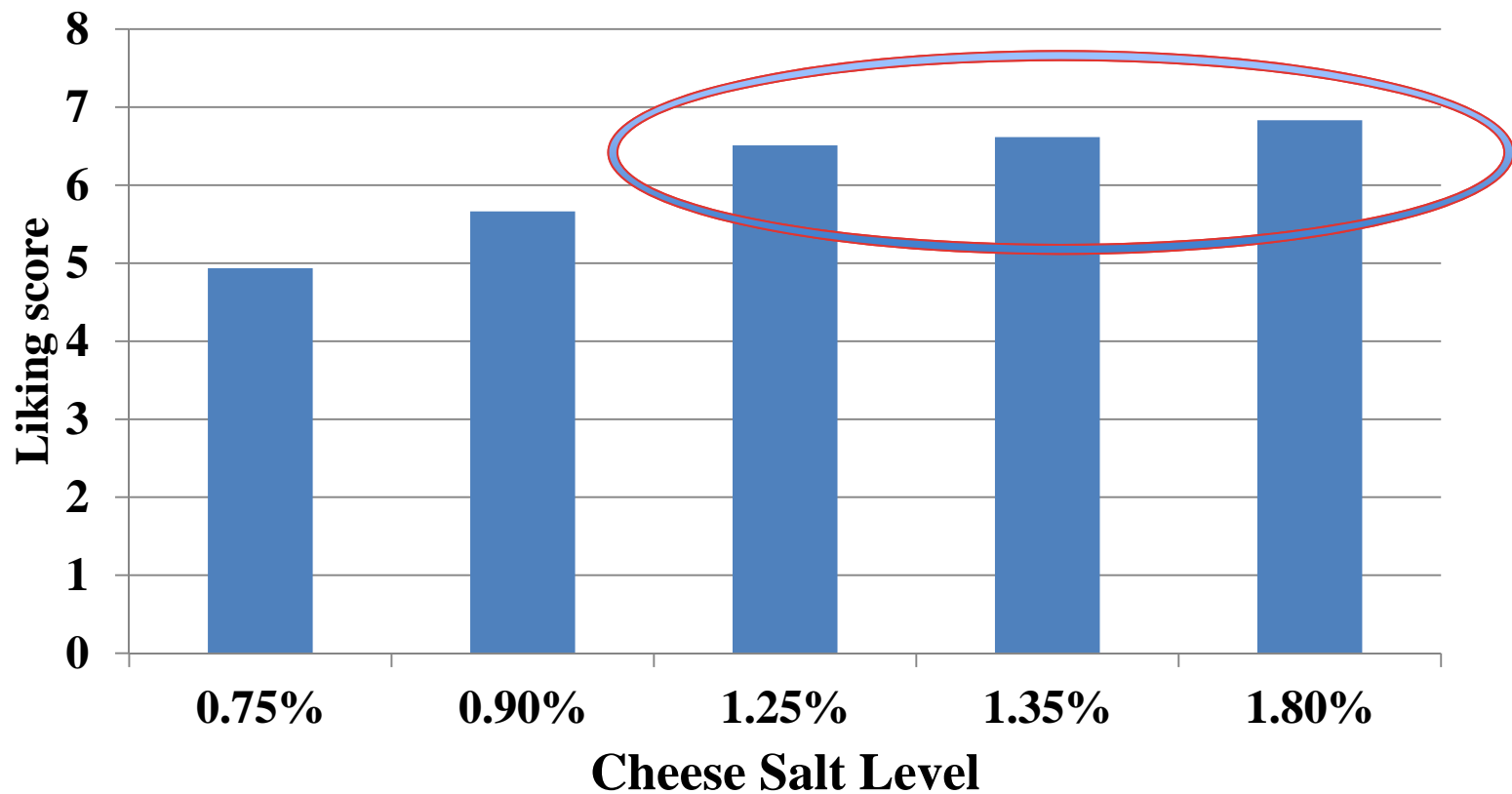
Lowering salt has less impact in a heated food



- Cheese when served hot as a quesadilla had higher scores and was still liked at 0.75% salt

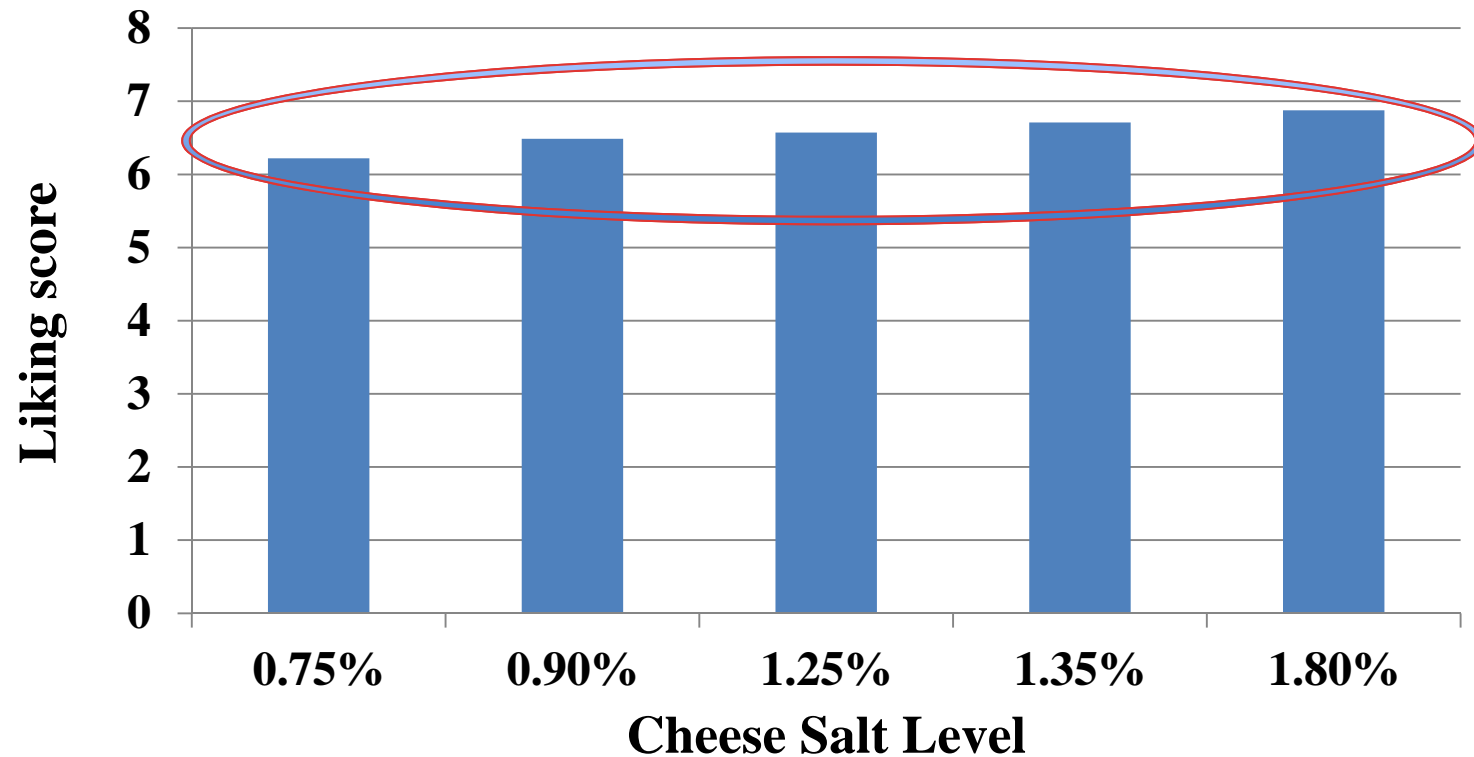
9-point hedonic scale

Mozzarella - Cold



No Difference in Mean Liking Scores down to 1.25% salt

Mozzarella - Pizza



Mean Scores remain at Like Slightly at all Salt Levels

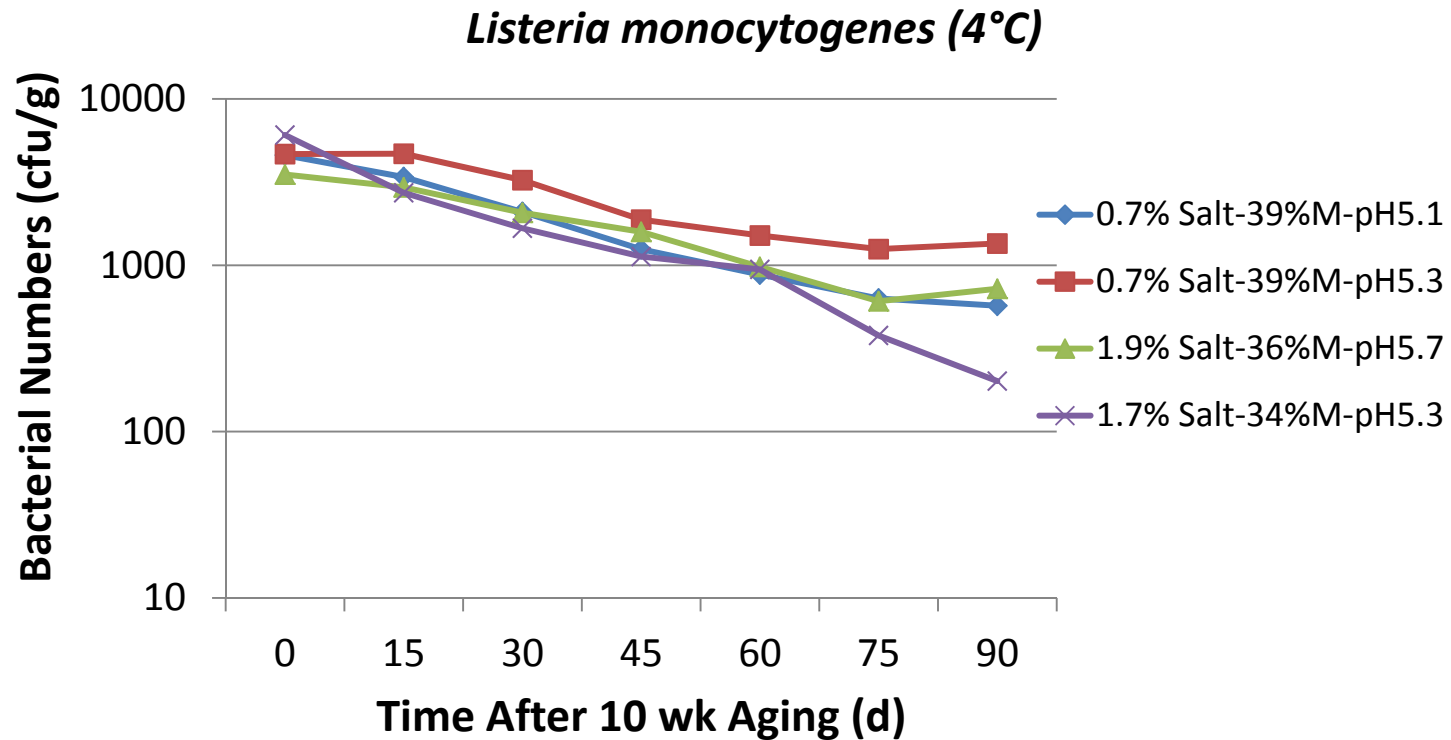
Salt in Cheese and Food Safety

Listeria monocytogenes

Safety of Low Salt Cheese

- **Manufactured cheddar cheese**
 - *Normal Salt (1.7% to 1.8%)*
 - *Low Salt (0.7%)*
 - *Washed portion of curd to give high and low pH*
- **Aged cheese for 10 weeks**
- **Comminuted to 3 mm particle size**
- **Innoculate with 5 strain mixture of *Listeria monocytogenes***
- **Vacuum package, store at 4, 10 and 21° C**

Subash Srethra et al, 2011



- **No growth observed**
- **Similar die off at 4, 10 and 21° C**
- **Salt Level not a significant factor**

Conclusions

- **Saltiness in cheese is expected.**
- **Small salt reductions lower overall consumer liking.**
- **Rosey and Burnt flavors increase with lower salt in cheddar cheese.**
- **Less effect in heated foods containing cheese such as pizza and quesadillas.**

Conclusions

- **Salt plays a part in whey expulsion from cheese curd.**
- ***Lactococcus* starter culture survives longer as salt level is reduced.**
- **No apparent effect on *Listeria* survival from low salt content.**

Acknowledgments

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