More Chocolate! The FUN Biochemistry of Cavity Prevention

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Milk consumption and acne in teenage boys.
J Am Acad Dermatology. 2008 May

Cariogenicity of Different Commercially Available Bovine Milk Types in a Biofilm Caries Model
Pediatric Dentistry January 2014


Verakaki E1, Duggal MS.

Plaque pH and Dental Retention after Consumption of Different Types of Chocolates
Published online June 30, 2016

The acidogenicity of various chocolates available in Indian market: a comparative study.
M Hegde A1, Shetty R2, Sequeira AR3.


Best article ever!:
99.7% within 3 standard deviations

95% within 2 standard deviations

68% within 1 standard deviations
99.7% within 3 standard deviations

95% within 2 standard deviations

68% within 1 standard deviations

μ - 3σ, μ - 2σ, μ - σ, μ, μ + σ, μ + 2σ, μ + 3σ
NEW PARADIGM AHEAD
Dr. Lucas’ Cracker Hypothesis:

A large majority of previously *unexplained* cavities in children ages 5 and under were caused by frequent cracker or dry cereal consumption. (Usually 3 or more times a day.)

I used to call these children “high risk for caries”

Because the biochemistry tells us that time that carbohydrates touch teeth is all that really matters
Dark Chocolate is Better than a Cracker
Throwing Out Crackers is More Effective Than Flossing
Equation of Solubility of Hydroxyapatite

\[
\text{Ca}_{10}\text{(PO}_4\text{)}_6\text{(OH)}_2(\text{s}) \rightarrow 10 \text{Ca}^{2+} \text{ (aq)} + 6 \text{PO}_4^{3-} \text{ (aq)} + 2 \text{OH}^{-} \text{ (aq)}
\]

\[K_{sp} = 6.8 \times 10^{-37}\]
The Stephan Curve

This is more then about 20 minutes if the starches are stickier
Time \( pH < 5.5 \)
CARBS
Lactate Dehydrogenase

Pyruvate $\rightarrow$ NADH $\rightarrow$ Lactate

Lactate Dehydrogenase
Pyruvate’s Choice!
**Cellular Respiration**

\[ \text{Glucose} + 6 \text{O}_2 \rightarrow 6 \text{CO}_2 + 6 \text{H}_2\text{O} + 38 \text{ATP} \]

**Lactic Acid Fermentation**

\[ \text{Lactic Acid} \rightarrow \text{Lactate} \]

**Electron Transport Chain**

**Krebs Cycle**

**Glycolysis**

**Low Affinity Pathway**

**High Affinity Pathway**

**Sexy Pathway**

**Sucrose Pathway**

**Only 2 ATP!**
20 Minutes

oxygen molecule
Glycogen molecule
Concentration Matters!
Cariogenicity of Different Commercially Available Bovine Milk Types in a Biofilm Caries Model
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Bovine Milk Study Results

“Only whole and whole lactose-free milk kept pH above the demineralization threshold.”

Skim and semi-skim milk induced similar demineralization to the sucrose control, albeit slightly lower for semi-skim milk (P<.05)
Diffusibility Matters!
FEED ME, SEYMOUR!
Flour Matters!
Complex carb: 

Simple carb: 

Processed carb:
THE EXPLOSIVE TRUTH ABOUT MODERN FLOUR MILLS

Ever since the Washburn flour mill explosion near Minneapolis in 1878 killed 18 people, the milling industry has tried to reduce the risk of flour particles igniting into flour bombs.

“Flour dust that is suspended in air is more explosive than coal dust,” Paul Steinlage, milling manager, told Food Engineering Magazine this month.

Throughout agriculture and food processing, there were 115 reported dust explosions [pdf] between 1994 and 2003, the most recent numbers available, most of them in grain elevators.
Crackers (cheddar)
- 6 g Fat
- 19 g Carb
- 0 g Fiber
- 1 g Sugar
- 3 g Protein

Ratio of Starch
- 19 g Starch
- 9 g Fat/Protein
- 19/9 = 2.1

70% Dark Chocolate
- 17 g Fat
- 21 g Carb
- 5 g Fiber
- 12 g Sugar
- 3 g Protein

Ratio of Starch
- 16 g Starch
- 25 g Fat/Fiber/Protein
- 16/25 = 0.64

Whole Milk

Skim Milk

11 g sugar
16 g fat/protein
11/16 = 0.68
11 g sugar
8 g fat/protein
11/8 = 1.38
Sucrose
Sorbitol
Plain European Chocolate
Diet Chocolate
Plain English Chocolate
Milk English Chocolate
Milk European Chocolate
White Chocolate
Milk Chocolate with Hazelnuts

Verakaki E1, Duggal MS.
“A comparison of different kinds of European chocolates on human plaque pH.”
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“A comparison of different kinds of European chocolates on human plaque pH.”
API = Acidogenic Potential Index

<table>
<thead>
<tr>
<th>Tested products</th>
<th>Mean area below “critical pH” (±SD)</th>
<th>Mean time below pH 5.7 (min, ±SD)</th>
<th>API</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sucrose</td>
<td>1.38 (1.03)</td>
<td>6.91 (3.29)</td>
<td>1.00</td>
</tr>
<tr>
<td>Sorbitol</td>
<td>0.00*</td>
<td>0.00*</td>
<td>0.00</td>
</tr>
<tr>
<td>Diet chocolate</td>
<td>0.00*</td>
<td>0.00*</td>
<td>0.036</td>
</tr>
<tr>
<td>Plain European chocolate</td>
<td>0.20 (0.34)</td>
<td>2.15 (2.79)</td>
<td>0.41</td>
</tr>
<tr>
<td>Plain English chocolate</td>
<td>0.88 (1.23)</td>
<td>3.98 (4.13)</td>
<td>0.66</td>
</tr>
<tr>
<td>Milk English chocolate</td>
<td>0.90 (1.32)</td>
<td>4.41 (5.15)</td>
<td>0.93</td>
</tr>
<tr>
<td>Milk European chocolate</td>
<td>1.12 (1.78)</td>
<td>4.83 (5.29)</td>
<td>0.94</td>
</tr>
<tr>
<td>White chocolate</td>
<td>0.46 (1.12)</td>
<td>2.86 (3.55)</td>
<td>0.88</td>
</tr>
<tr>
<td>Milk chocolate with hazelnuts</td>
<td>0.60 (1.40)</td>
<td>3.23 (6.71)</td>
<td>0.45</td>
</tr>
</tbody>
</table>

*significantly different to sucrose

**TABLE 3** - Mean area below “critical pH” (5.7), mean time spent below “critical pH” (minutes), and API for all the test chocolates and controls (±SD).
Figure 1. Comparison of mean plaque pH at various intervals among different types of chocolates.
The acidogenicity of various chocolates available in Indian market: a comparative study.
M Hegde A1, Shetty R2, Sequeira AR3.

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Throwing Out Crackers is More Effective Than Flossing
Easy (non-crazy) Crackers Analogy

Dried Fruit : Fresh Fruit
Crackers : Bread

“Crackers aren’t bad for you, they just get stuck to your teeth like dried fruit does, and are nine times stickier than bread.”

“We recommend eating crackers no more than once a day.”
**Tooth Snack Guide**

**Won’t Cause Cavities**
- (Low Carb foods)
  - Raw, Crunchy Vegetables
  - Raw, Leafy Vegetables
  - Cheese
  - Nuts
  - 100% Nut butters
  - All Meats
  - All Fats
  - Water

**(Usually) Won’t Cause Cavities**
- Whole Milk
- Fresh Fruit
- Whole grain bread
- Popcorn
- Smoothies
- Dark Chocolate (>70% Cacao)
- Yogurt
- Ice Cream
- Dips & Sauces
- Oatmeal

**Causes Cavities Easily**
- Candies
- Soda
- Juice
- Chocolate milk
- Cookies
- Dried fruit
- Fruit snacks/straps
- Dried flour cereals
- Pretzels
- Crackers
- Oranges & Bananas
- Sports Drinks

**Important Prevention Tips**
- Always try to have a sip of water after every meal or snack!
- Give your child 5 to 6 organized "mini-meals" a day with only water in between.
- Disorganized eating or drinking will cause cavities even with healthy foods!
- Help your child brush their teeth daily until they are six or seven years old.
- Only have water after the night time brushing.
- Floss teeth if they are touching for additional protection.
- Schedule an infant screening exam with your dentist at age one.
- Fluoride application at your dentist every six months can also help reduce cavities by 20 to 30%.
- Never leave a bottle in bed with baby!

**Provided by your dentist:**

- Dentists who print this out for patients can put name and office contact info here.

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*These are always exceptions, especially dry mouth, acid reflux, genetic anomalies, hypoplasia, and unforeseeable circumstances.*
Dr. Lucas’ Three Principles Review

1) Brush well every night. Only water afterwards.
2) Eat 5-6 mini-meals a day, and only water in between
3) Eat snacks from the better for teeth categories

**Snack Foods are “the secret”**
Recent study at Seattle Children’s showed children who had higher vitamin D blood levels had less caries rate.

Vitamin D is correlated with increased calcium and phosphorous in saliva.

Vitamin D has been shown to activate defense’s - peptides that facilitate phagocytosis.

Imagine if you have a child who is vitamin D deficient: Probably very little calcium in saliva and worse immune response.

This could explain that other subset that isn't diet, isn’t reflux… no calcium in saliva from lack of sun/animal fat (only sources of vitamin D).

Kids with Celiac Disease have enamel that falls apart. Perhaps this is from their gut not being able to absorb vitamin D?

I give my kids a drop of infant Vitamin D3 every night in their water. (D3 is better absorbed than D2.)

Flinstones have Vitamin K as well, which is needed for Vitamin D to work.
SWITCH Principles

This is your BRAIN:
EMOTIONAL

ELEPHANT

RATIONAL

RIDER

In any conflict, the RIDER is overmatched. But if BOTH are on board, CHANGE is EASY.

NOTES by RACHEL SMITH | @ninmah
TheDentistDad.com/ Dentists

Free 30 minute Training Video for assistants / dentists on How to Use a Snack Guide and Have Parents Love You With 12 Extra Tips