Non-Dairy (Base) Ingredients
Soy, Almond, Rice, Cashew, Coconut, etc
Two Parts

• Non-animal vs Animal Milk Concerns
• Technical implications of Non-Animal Milks (NAM)
Two Parts

• Non-animal vs Animal Milk Concerns
• Technical implications of NAM
“Never before have we seen an increase like this in alternative milks,”

-Kim Larson, Academy of Nutrition and Dietetics.
Current Non-Animal Milks (NAM)

- Soy milk
- Rice milk
- Barley milk
- Oat milk
- Wheat milk
- Almond milk
- Peanut milk
- Hazelnut milk
- Green pea milk
- Sesame milk
- Pecan milk
- Flax milk
- Walnut milk
- Hemp milk
- Quinoa milk
- Soy milk
- Rice milk
- Cashew milk
- Macadamia milk
- Pistachio milk
- Tiger nut milk
- Tapioca milk
What is Milk?
Definition of Milk 21CFR131.110

Milk is the lacteal secretion, practically free from colostrum, obtained by the complete milking of one or more healthy cows. Milk that is in final package form for beverage use shall have been pasteurized or ultrapasteurized, and shall contain not less than 8 1/4 percent milk solids not fat and not less than 3 1/4 percent milkfat. Milk may have been adjusted by separating part of the milkfat therefrom, or by adding thereto cream, concentrated milk, dry whole milk, skim milk, concentrated skim milk, or nonfat dry milk. Milk may be homogenized.
“Milk” means the lacteal secretion of milking animals, and includes skim milk and cream.
"Milk" means the normal lacteal secretion, practically free of colostrum, obtained by the complete milking of one or more healthy milking animals, and includes skim milk and cream.
Naming Controversy - Broad Definition?
All Information (Except Text) for S.130 - DAIRY PRIDE Act
115th Congress (2017-2018) | Get alerts

BILL Hide Overview X

Sponsor: Sen. Baldwin, Tammy [D-WI] (Introduced 01/12/2017)
Committees: Senate - Health, Education, Labor, and Pensions
Latest Action: Senate - 01/12/2017 Read twice and referred to the Committee on Health, Education, Labor, and Pensions. (All Actions)

Tracker: Introduced Passed Senate Passed House To President Became Law

There is 1 version of this bill. View text »

Click the check-box to add or remove the section, click the text link to scroll to that section.
Titles Actions Overview All Actions Cosponsors Committees Related Bills Subjects Latest Summary All Summaries

Titles (3)

Short Titles

Short Titles - Senate

Short Titles as Introduced
DAIRY PRIDE Act
Defending Against Imitations and Replacements of Yogurt, Milk, and Cheese To Promote Regular Intake of Dairy Everyday Act

Official Titles

Official Titles - Senate

Official Titles as Introduced
A bill to require enforcement against misbranded milk alternatives.
Bill would protect the integrity of dairy products by enforcing existing labeling requirements. Would require that non-dairy products made from nuts, seeds, plants, and algae no longer be confusingly labeled with dairy terms like milk, yogurt, and cheese.
Regulations in Canada and the United Kingdom don’t allow the use of “milk” as a name for Almond Breeze, the same brand sold in the United States as “almond milk.”
Almond milk, Lemond said, contains only about four to six almonds in an 8-ounce glass. The rest is water and added vitamins. For almond milk and other plant-based milks, sweeteners need to be added to make them palatable. (https://www.usatoday.com/story/news/nation-now/2017/02/28/got-milk-kind-you-should-drinking/98322592/)
“First, of all foods, none surpasses [animal] milk as a single source of those dietary elements needed for the maintenance of proper health, especially in children and older citizens.”

Author?
Nutrition, Market, Halo
US dairy milk sales expected to decline until 2020, Mintel report shows

By Douglas Yu

• 2015-2020 period, dairy milk - <$16bn
• NAM @ $3bn.

A recent Mintel report says the US dairy category will see a continuous sales decline, in contrast to its strong growth in 2014 when there was a combination of high milk prices, increased international demand, and dairy milk repositioning itself to align with health trends.

The market research firm forecast total US dairy milk sales to decrease to $15.9bn, an 11% drop during the 2015 to 2020 period.

Non-dairy to reach $3bn in four years

"US fluid milk consumption has been on the decline for decades... lower consumption comes as consumers increase their consumption of other beverages, challenging the dairy milk industry to be seen as more than a commodity, but rather something that can be consumed at multiple drinking occasions with a variety of benefits and applications," Mintel said.

Nutrition and taste are main drivers
Reasons for consuming non-dairy milk, January 2015

- 49% It’s nutritious
- 45% I like the taste
- 37% It’s a good source of protein
- 24% Drinking less (cow) dairy milk
- 24% Lactose sensitivity or intolerance to dairy

Base: 1,090 internet users age 18+ who have consumed non-dairy milk in the past three months
Source: LIGHTSPEED GMI/MINTEL
“We also had to figure out how to get this product category [NAM] to market. Dairy milk is a staple food that we consider a fundamental part of the scenery in a supermarket. Why not position fresh soymilk to be as close as possible?”

-- Steven Demos, CEO of WhiteWave, 2001
“On one hand I can agree with the gripe of the dairy industry that these alternative milks that don’t have nutrition are harvesting unfairly the health halo of milk,” Lowry said. Although many almond milk producers have varieties containing extra protein, Lowry said he doesn’t believe many almond milk drinkers are aware of the lack of protein.

Ripple co-founder, Adam Lowry

Broadening the definition

• March 2016: the Plant-Based Foods Association is established representing manufacturers of foods intended to replace animal products such as meats, dairy and eggs

• March 2017: the Good Food Institute petitions FDA to amend the definition of the common or usual names of foods.

OUR MISSION
To ensure a fair and competitive marketplace for businesses selling plant-based foods intended to replace animal products such as meats, dairy, and eggs, by promoting policies and practices that improve conditions in the plant-based foods industry, and educating consumers about the benefits of plant-based foods.

We aim to:
Engage in education, public relations, and media outreach to increase visibility for plant-based foods and boost consumer acceptance; Eliminate policies and practices that place plant-based meats, milks, eggs, and butters at an economic disadvantage, such as labeling restrictions; Change the debate on important public policy issues such as the dietary guidelines.
“Other products sold as ‘milks’ but made from plants (e.g., almond, rice, coconut, and hemp ‘milks’) may contain calcium and be consumed as a source of calcium, but they are not included as part of the dairy group because their overall nutritional content is not similar to dairy milk and fortified soy beverages (soymilk)...”

2015-2020 Dietary Guidelines for Americans
<table>
<thead>
<tr>
<th>Product</th>
<th>Milk (1%)</th>
<th>Almond</th>
<th>Cashew</th>
<th>Coconut</th>
<th>Rice</th>
<th>Soy</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Ingredients</td>
<td>3</td>
<td>3-15</td>
<td>3-15</td>
<td>9-15</td>
<td>8-12</td>
<td>2-18</td>
</tr>
<tr>
<td>Calories</td>
<td>102</td>
<td>25-270</td>
<td>40-360</td>
<td>45-80</td>
<td>120-130</td>
<td>70-140</td>
</tr>
<tr>
<td>Total Fat (g)</td>
<td>2.4</td>
<td>2-14</td>
<td>3-25</td>
<td>4-5</td>
<td>2.5</td>
<td>0-6</td>
</tr>
<tr>
<td>Total Carbs (g)</td>
<td>12</td>
<td>1-32</td>
<td>2-24</td>
<td>1-10</td>
<td>23-26</td>
<td>3-17</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>8</td>
<td>1-8</td>
<td>1-11</td>
<td>0-1</td>
<td>1</td>
<td>6-12</td>
</tr>
<tr>
<td>Sodium (mg)</td>
<td>107</td>
<td>100-260</td>
<td>105-470</td>
<td>0-180</td>
<td>65-105</td>
<td>5-160</td>
</tr>
<tr>
<td>Potassium (mg)</td>
<td>366</td>
<td>0-190</td>
<td>20</td>
<td>40-72</td>
<td>20-70</td>
<td>30-460</td>
</tr>
<tr>
<td>Vitamin A (%)</td>
<td>5</td>
<td>0-10</td>
<td>0-10</td>
<td>10</td>
<td>10</td>
<td>0-15</td>
</tr>
<tr>
<td>Calcium (%)</td>
<td>28</td>
<td>2-50</td>
<td>2-30</td>
<td>4-45</td>
<td>30-45</td>
<td>0-45</td>
</tr>
<tr>
<td>Vitamin D (%)</td>
<td>24</td>
<td>0-25</td>
<td>25-30</td>
<td>0-30</td>
<td>25</td>
<td>25-30</td>
</tr>
<tr>
<td>Riboflavin (%)</td>
<td>26</td>
<td>2-30</td>
<td>ns</td>
<td>ns</td>
<td>0</td>
<td>6-30</td>
</tr>
<tr>
<td>Phosphorus (%)</td>
<td>22</td>
<td>2-4</td>
<td>ns</td>
<td>ns</td>
<td>6-15</td>
<td>8-25</td>
</tr>
<tr>
<td>Magnesium (%)</td>
<td>6</td>
<td>4</td>
<td>10</td>
<td>8-10</td>
<td>8</td>
<td>6-15</td>
</tr>
<tr>
<td>Vitamin B12 (%)</td>
<td>18</td>
<td>0-25</td>
<td>50</td>
<td>25-50</td>
<td>0-25</td>
<td>20-50</td>
</tr>
<tr>
<td>Niacin (eq) (%)</td>
<td>10</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>4</td>
</tr>
</tbody>
</table>
### Nutrition Facts

**Serving Size:** 1 cup (240mL)  
**Servings Per Container:** 4

<table>
<thead>
<tr>
<th>Amount Per Serving</th>
<th>% Daily Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Calories</strong></td>
<td>35</td>
</tr>
<tr>
<td>35</td>
<td>5%</td>
</tr>
<tr>
<td><strong>Total Fat</strong></td>
<td>3.5g</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>0g</td>
</tr>
<tr>
<td>Trans Fat</td>
<td>0g</td>
</tr>
<tr>
<td><strong>Cholesterol</strong></td>
<td>0mg</td>
</tr>
<tr>
<td><strong>Sodium</strong></td>
<td>85mg</td>
</tr>
<tr>
<td><strong>Total Carbohydrate</strong></td>
<td>1g</td>
</tr>
<tr>
<td>Dietary Fiber</td>
<td>0g</td>
</tr>
<tr>
<td>Sugars</td>
<td>0g</td>
</tr>
<tr>
<td><strong>Protein</strong></td>
<td>0g</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>10%</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>0%</td>
</tr>
<tr>
<td>Calcium</td>
<td>10%</td>
</tr>
<tr>
<td>Iron</td>
<td>0%</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>35%</td>
</tr>
<tr>
<td>Folate</td>
<td>8%</td>
</tr>
<tr>
<td>Vitamin B₁₂</td>
<td>60%</td>
</tr>
<tr>
<td>Magnesium</td>
<td>8%</td>
</tr>
<tr>
<td>Zinc</td>
<td>4%</td>
</tr>
<tr>
<td>Selenium</td>
<td>8%</td>
</tr>
</tbody>
</table>

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

<table>
<thead>
<tr>
<th>Calories:</th>
<th>2,000</th>
<th>2,500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Fat</td>
<td>Less than 65g</td>
<td>80g</td>
</tr>
<tr>
<td>Sat Fat</td>
<td>Less than 20g</td>
<td>25g</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>Less than 300mg</td>
<td>300mg</td>
</tr>
<tr>
<td>Sodium</td>
<td>Less than 2,400mg</td>
<td>2,400mg</td>
</tr>
<tr>
<td>Total Carbohydrate</td>
<td>Less than 300g</td>
<td>375g</td>
</tr>
<tr>
<td>Dietary Fiber</td>
<td>25g</td>
<td>30g</td>
</tr>
</tbody>
</table>

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

We work hard to keep the information on this website up-to-date, but please check the label on your product for the most current nutrition facts.
Figure 3: Almond Milk CO₂ Breakdown

Figure 4: Cow Milk CO₂ Breakdown
Soy Infant Formula

Introduction

Soy formula is an infant food made using soy protein and other components. It is fed to infants as a supplement or replacement for human milk or cow milk formula.

Why are people concerned about soy infant formula?

The safety of soy infant formula has been debated because it typically contains a class of compounds called isoflavones. Isoflavones are naturally occurring compounds found primarily in beans and other legumes, including soybeans, peanuts, and chickpeas.

The primary isoflavones found in soy products, including tofu, soy milk and soy formula, are genistein, daidzein, and to a smaller extent, glycitein. These isoflavones are referred to as phytoestrogens because they are found in plants (phyto) and because of their ability to act like the hormone estrogen in the body.

Although there have been no specific health problems documented in human infants receiving soy formula, it is recognized that infants go through developmental stages that are sensitive to estrogens. Therefore, infants are more likely than adults to be vulnerable to the estrogen-like effects of the phytoestrogens in soy. In some cases, the health effects resulting from a soy-based diet may not be apparent until years later.

What are the potential health effects?

Animal studies indicate that health effects of possible concern include early onset of puberty in females and alterations in development of breast tissue.
"We found that children who are consuming non-cow's milk like rice, almond and soy milk tended to be a little bit shorter than children who consumed cow's milk," said Dr. Jonathon Maguire, the study's lead author and a pediatrician and researchers at St. Michael's Hospital in Toronto. "For example, a 3-year-old child consuming three cups of non-cow's milk relative to cow's milk was on average 1.5 centimeters shorter."

**Abstract**

**Background:** Cow milk consumption in childhood has been associated with increased height, which is an important measure of children's growth and development. Many parents are choosing non-cow milk beverages such as soy and almond milk because of perceived health benefits. However, noncow milk contains less protein and fat than cow milk and may not have the same effect on height. **Objective:** We sought to determine whether there is an association between noncow milk consumption and lower height in childhood and assess whether cow milk consumption mediates the relationship between noncow milk consumption and height. **Design:** This was a cross-sectional study of 5034 healthy Canadian children aged 24-72 mo enrolled in the Applied Research Group for Kids cohort. The primary exposure was the volume of noncow milk consumption (number of 250-mL cups per day). The primary outcome was height, which was measured as height-for-age z score. Multivariable linear regression was used to determine the association between noncow milk consumption and height. A mediation analysis was conducted to explore whether cow milk consumption mediated the association between noncow milk consumption and height. **Results:** There was a dose-dependent association between higher noncow milk consumption and lower height ($P < 0.0001$). For each daily cup of noncow milk consumed, children were 0.4 cm (95% CI: 0.2, 0.8 cm) shorter. In the mediation analysis, lower cow milk consumption only partially mediated the association between noncow milk consumption and lower height. The height difference for a child aged 3 y consuming 3 cups noncow milk/d relative to 3 cups cow milk/d was 1.5 cm (95% CI: 0.8, 2.0 cm). **Conclusions:** Noncow milk consumption was associated with lower childhood height. Future research is needed to understand the causal relations between noncow milk consumption and height.
Statement from FDA Commissioner Scott Gottlieb, M.D., on modernizing standards of identity and the use of dairy names for plant-based substitutes

For Immediate Release

September 27, 2018

Statement

Consumers should be able to know at a quick glance what type of product they’re purchasing for themselves and their families. Implementing clear and transparent food labels and claims is an issue I’ve made a high priority. We’ve outlined these goals in a new, multi-year Nutrition Innovation Strategy released earlier this year. As part of this plan, we promised to address issues related to modernizing the outdated framework for food standards to allow industry flexibility for innovation, for example to produce more healthful foods, while maintaining the basic nature, essential characteristics and nutritional integrity of key food products.

The wide variety of plant-based foods that are being positioned in the marketplace as substitutes for standardized dairy products has been the subject of much discussion in our initial work on the Nutrition Innovation Strategy. The rising demand for plant-based products, like soy-based alternatives to cheese and nut-based alternatives to milk, has created a growing number of new food choices in supermarket aisles. However, these products are not foods that have been standardized under names like “milk” and “cheese.” The FDA has concerns that the labeling of some plant-based products may lead consumers to believe that those products have the same key nutritional attributes as dairy products, even though these products can vary widely in their nutritional content. It is important that we better understand consumers’ expectations of these plant-based products compared to dairy products.
However, we must also ensure that the labeling of such products does not mislead consumers, especially if this could compromise their health and well-being.

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The Future?
Geltor seeks to disrupt the gelatin market with potentially game-changing animal-free alternative

By Elaine Watson
15-Aug-2016 - Last updated on 31-Aug-2016 at 00:29 GMT

Co-founders Alex Lorestani (left) and Nick Ouzounov (right)
‘VEGAN’ MILK BRAND PERFECT DAY SECURES $24.7 MILLION TO ‘DISRUPT THE DAIRY INDUSTRY’

Nadia Murray-Ragg
Social Media Coordinator and Freelance Journalist | Wellington, New Zealand | Contactable via nadia@livekindly.co

Posted by Nadia Murray-Ragg | Feb 28, 2018
Two Parts

- Non-animal vs Animal milk concerns
- Technical implications of NAM
First, some labels

- Almond Milk (Water, Almonds), Liquid Sugar (Sugar, Water), Coconut Oil, Corn Syrup, Less Than 2% Of Pea Protein, Vegetable Gums (Carob Bean Gum, Guar Gum), Mono And Diglycerides, Peanut Oil, Salt, Natural Flavor (Coconut).


- Cashewmilk (Filtered Water, Cashews), Cane Sugar, Organic Coconut Oil, Organic Tapioca Syrup, Pea Protein, Sea Salt, Guar Gum, Vanilla Extract, Natural Flavors, Locust Bean Gum.

First, some labels

- **Almond Milk** (Water, Almonds), Liquid Sugar (Sugar, Water), Coconut Oil, Corn Syrup, Less Than 2% Of Pea Protein, Vegetable Gums (Carob Bean Gum, Guar Gum), Mono And Diglycerides, Peanut Oil, Salt, Natural Flavor (Coconut).


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Frozen Desserts – Rule #1: In order to make a reasonably successful frozen dessert base you minimally need:

1. Water – continuous phase, solvent, ice structure
2. Sucrose – freezing point depressant, sweetness
3. Stabilizer (hydrocolloid) – water behavior, viscosity, air entrainment
Frozen Desserts - Rule #2:
Most reasonably successful frozen desserts behave as if they were a ~25% sucrose solution.

- Freezer performance/design
- Flow, filling, inclusions/var’s
- Storage temperature
- Dipping cabinet temperature
Frozen Desserts - Rule #3:
As a material, ice cream is extremely difficult to characterize, it is extremely complex.

- Milkfat structures
- Protein reactions
- Interfacial phenomena
- Water/Ice behavior
- Interactions
  - Not at equilibrium

Figure 2—PCA biplot of the microstructure parameters/instrumental measurements. Ice cream product samples are represented by a 3-digit code and the vectors represent the microstructure parameters tested. The following shapes represent the levels of fat present in the ice cream products.

Warren and Hartel, 2018
Frozen Desserts - Rule #3:
As a material, ice cream is extremely difficult to characterize, it is extremely complex.

- Milkfat structures
- Protein reactions
- Interfacial phenomena
- Water/Ice behavior
- Interactions
- Not at equilibrium

Figure 5. Changes in complete melting time of seven different types of ice cream samples over three different storage days. (Abbreviations are: M 12% milk fat, H 12% hazelnut oil, O 12% olive oil, MH 6% milk fat-6% hazelnut oil, MO 6% milk fat-6% olive oil, HO 6% hazelnut oil-6% olive oil, MHO 4% milk fat-4% hazelnut oil-4%olive oil).

Storage at -35C; Güven et al., 2018
Ingredients impacting Rules #1-3

• Almond Milk (Water, Almonds), Liquid Sugar (Sugar, Water), Coconut Oil, Corn Syrup, Less Than 2% Of Pea Protein, Vegetable Gums (Carob Bean Gum, Guar Gum), Mono And Diglycerides, Peanut Oil, Salt, Natural Flavor (Coconut).


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Primarily solved by standardization, Rule #2
What do we mean by convention?

• Mass of water

• Collective and other contributions of:
  • Sugars/CHO (lactose)
  • Salts
  • Ethanol
  • Sugar alcohols
  • Rare sugars

• Antifreeze proteins
Freezing point calculations

- Difference between 0°C and temp at which mix first freezes
- All solutes can contribute to FPD
- \( FDP_{\text{total}} \) calculations are based on determining how much sugar (\( FDP_{SE} \)) and salt (\( FDP_{SA} \)) exist
- \( FDP_{SE} = \)
  - \( \text{NMS} \times 0.545 \)
  - \( \text{WS} \times 0.765 \)
  - \( S + \)
  - \( 10 \text{ DE CSS} \times 0.2 \)
  - \( 36 \text{ DE CSS} \times 0.6 \)
  - \( 62 \text{ DE CSS} \times 1.2 \)
  - \( \text{HFCS} \times 1.8 \)
  - \( F \times 1.9 \)

NMS=nonfat milk solids, WS=whey solids, S=sucrose, F=fructose, CSS=corn syrup solids, SE=sucrose equiv., SA=salt equiv.
FP calculations, cont’d

\[ FDP_{SA} = \frac{((NMS + WS) \times 2.37)}{W} \text{ where } W=\%\text{water} \]

Result is expressed in degrees C

\[ FDP_{total} = FDP_{SE} + FDP_{SA} \]
Ingredients left (Rule #3)

- Almonds, Coconut Oil, Pea Protein, Mono And Diglycerides, Peanut Oil
- Soybeans, Organic Soybean Oil,
- Coconut
- Cashews, Coconut Oil, Pea Protein
- Sunflower And/Or Safflower And/Or Canola Oil, Sunflower Lecithin
Beyond water and solute

• Minor components, particulates, yes, but by broad categories:

  • Protein – structure, water behavior, flavor, flavor matrix
  • Lipid – structure (flow, melt, etc), flavor, flavor matrix
  • Amphiphiles – milkfat structure, interfacial phenom.
Roles in FD of Other Ingredients

- **Protein**
  - Structure
  - Flavor
  - Nutrition (good and bad)
- **Lipid**
  - Structure (+amphiphiles)
  - Flavor
  - Nutrition
- **Mineral**
  - Structure
  - Nutrition
- **Simple sugars**
  - Sweetness/flavor
  - Freezing point
  - Digestion
- **Hydrocolloids**
  - Water structure/viscosity
  - Fiber
- **Particulates**

Current Non-Animal Milks (NAM)

- “Soy milk”
- “Rice milk”
- “Barley milk”
- “Oat milk”
- “Wheat milk”
- “Almond milk”
- “Hazelnut milk”
- “Sesame milk”
- “Rice milk”
- “Cashew milk”
- “Macadamia milk”
- “Peanut milk”
- “Almond milk”
- “Sunflower milk”
- “Potato milk”
- “Green pea milk”
- “Algae milk”
- “Banana milk”
- “Pecan milk”
- “Quinoa milk”
- “Hemp milk”
- “Walnut milk”
- “Tapioca milk”
- “Pistachio milk”
- “Hemp milk”
- “Tiger nut milk”
- “Walnut milk”
Roles in FD of Other Ingredients

- Protein
  - Structure
  - Flavor
  - Nutrition (good and bad)

- Lipid
  - Structure (+amphiphiles)
  - Flavor
  - Nutrition

- Mineral
  - Structure
  - Nutrition

- Simple sugars
  - Sweetness/flavor
  - Freezing point
  - Digestion

- Hydrocolloids
  - Water structure/viscosity
  - Fiber

- Particulates

Comparative Studies??

Current Non-Animal Milks (NAM)

- "Potato milk"
- "Algae milk"
- "Barley milk"
- "Quinoa milk"
- "Peanut milk"
- "Banana milk"
- "Pecan milk"
- "Oat milk"
- "Wheat milk"
- "Almond milk"
- "Hazelnut milk"
- "Soy milk"
- "Cashew milk"
- "Sesame milk"
- "Macadamia milk"
- "Sunflower milk"
- "Green pea milk"
- "Rice milk"
- "Pistachio milk"
- "Macadamia milk"
- "Tapioca milk"
- "Flax milk"
- "Hemp milk"
- "Tiger nut milk"
- "Walnut milk"
## Protein Content (NAL database)

<table>
<thead>
<tr>
<th>%-age</th>
<th>Rice</th>
<th>Almond</th>
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<tr>
<td>Protein</td>
<td>0.42</td>
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<td>4.58</td>
<td>0</td>
<td>0</td>
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<td>Lipid</td>
<td>1.04</td>
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<td>8.57</td>
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<td>2.92</td>
<td>22.86</td>
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<td>5.83</td>
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Novel Plant Proteins: Implications of thermal denaturation

- Changes in solubility, hydrophobicity
- Protein reactivity with hydrocolloids, enzymatic activities
- Mouthfeel
- Cleanability
- Agglomeration
- Graininess
- Viscosity
- (Allergenicity)
- (Flavor)
Table 2—Thermal properties of rice flour, starch and proteins

<table>
<thead>
<tr>
<th>Samples</th>
<th>Denaturation temperature (°C)*</th>
<th>Enthalpy value of denaturation (Jg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albumin</td>
<td>73.3&lt;sup&gt;a&lt;/sup&gt;&lt;sup&gt;*&lt;/sup&gt;</td>
<td>2.88&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Globulin</td>
<td>78.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.14&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Glutelin</td>
<td>82.2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.79&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Prolamin</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Starch</td>
<td>84.7&lt;sup&gt;e&lt;/sup&gt;</td>
<td>10.53&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Rice flour</td>
<td>80.5&lt;sup&gt;d&lt;/sup&gt;</td>
<td>8.49</td>
</tr>
</tbody>
</table>

* 175, 180F = ~80, 82C
Fig. 1 DSC curves of soymilk with different protein concentration. 1 – 1.8%, 2 – 3.6%, 3 – 5.4%, 4 – 7.2%
Table 2
Thermal and functional properties of the extracted protein isolates from wild almond using buffered saline borate (BSB) and NaOH

<table>
<thead>
<tr>
<th></th>
<th>BSB isolate</th>
<th>NaOH isolate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal properties</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Onset temperature (°C)</td>
<td>87.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>80.5&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Endset temperature (°C)</td>
<td>97.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>95.8&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Peak temperature (°C)</td>
<td>92.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>87.7&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Heat capacity (J/g)</td>
<td>1.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.1&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Functional properties (at pH = 7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface hydrophobicity</td>
<td>359 ± 5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>375 ± 6&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Water absorption capacity (g water/g protein)</td>
<td>2.6 ± 0.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.3 ± 0.4&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Oil absorption capacity (g oil/g protein)</td>
<td>3.1 ± 0.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.5 ± 0.7&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
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</table>

Values expressed are mean ± standard deviation

<sup>a, b</sup>In each row, means followed by the same letter are not significantly different (P > 0.05)
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Novel Plant Lipids: Implications of presence in FD

- Structure
  - Mouthfeel
  - Dryness
  - Melt character
- Flavor, release
- Amphiphiles
- Minor constituents, nutrition

- Solid fat content
- Crystalline species
Milkfat

Aging, initial temp at entry into freezing cylinder, 4°C

Final temp, dynamic freezing, -7°C

Figure 1: Milk Fat DSC Curve
Rice Bran Oil (RBO)

Fig. 3 Effect of surfactant addition on the melting profiles of rice bran oil (RBO). The surfactants used were the unevaporated fraction after molecular distillation at 140°C (UMD) and commercial mono- and diacylglycerol (MDG).

Nukit et al., 2014
Rankin’s Rules of Frozen Desserts - Rule #3: As a material, ice cream is extremely difficult to characterize, *it is extremely complex.*

- Milkfat structures
- Protein reactions
- Interfacial phenomena
- Water/Ice behavior
- Interactions
- Not at equilibrium

Figure 2—PCA biplot of the microstructure parameters/instrumental measurements. Ice cream product samples are represented by a 3-digit code and the vectors represent the microstructure parameters tested. The following shapes represent the levels of fat present in the ice cream products.

Warren and Hartel, 2018
Figure 5—Melt rate of ice cream as a function of increasing palm kernel oil (PKO) concentration in a fat blend of PKO and high-oleic sunflower oil.
<table>
<thead>
<tr>
<th>Type</th>
<th>Processing treatment</th>
<th>Saturated fatty acids</th>
<th>Monounsaturated fatty acids</th>
<th>Polyunsaturated fatty acids</th>
<th>Smoke point</th>
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<tbody>
<tr>
<td></td>
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<td></td>
<td>Total mono&lt;sup&gt;[17]&lt;/sup&gt;</td>
<td>Oleic acid (ω-9)</td>
<td>Linolenic acid (ω-3)</td>
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<td>Canola&lt;sup&gt;[21]&lt;/sup&gt;</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Coconut&lt;sup&gt;[23]&lt;/sup&gt;</td>
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<td>82.5</td>
<td>6.3</td>
<td>6</td>
<td>1.7</td>
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<tr>
<td>Corn&lt;sup&gt;[24]&lt;/sup&gt;</td>
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<td>Cottonseed&lt;sup&gt;[26]&lt;/sup&gt;</td>
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<td>Safflower&lt;sup&gt;[33]&lt;/sup&gt;</td>
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<td>Soybean&lt;sup&gt;[34]&lt;/sup&gt;</td>
<td></td>
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</tbody>
</table>

Values as percent (%) by weight of total fat.
Conclusions

• Remember the rules
• Consider protein, lipid (and other) contributions
• Labeling changes?
• More practical knowledge than public, much not known at all.
Non-Dairy (Base) Ingredients
Soy, Almond, Rice, Cashew, Coconut, etc

Scott A. Rankin, PhD
University of Wisconsin-Madison
October 22, 2018
FDC Technology Conference

Beth Panko Briczinski, Ph.D.
Senior Science Advisor for Milk Safety
(formerly National Milk Producers Fed)