

# Plant-Based Milk and Meat Alternatives

## Take Them or “Leaf” Them?

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# Today's Presenter



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# Webinar Agenda

- Why plant-based alternatives?
- Plant-Based Protein and Health
- Plant-Based Milk Alternatives
- Plant-Based Meat Alternatives
- Key Takeaways



# Today's Objectives

- Participants will be able to:
  - Discuss reasons individuals choose plant-based alternatives
  - Describe potential health benefits of plant-based protein on chronic disease
  - Identify common types of plant-based milk and meat alternatives
  - Compare benefits, drawbacks of plant-based milk and meat alternatives to animal milk and protein sources

# Why do people choose plant-based alternatives?

- Ethical reasons
- Environmental reasons
- Health reasons
- Religious or cultural
- Personal preference



Appetite. 2017 Feb 1;109:40-47.  
Foods; 2020; 10: 24.

# Plant-Based Milk

- Lactose intolerance
  - Globally – 68% of adults
  - US – 36% of adults
- Cow's milk allergy
  - Most common food allergy in children under 3 years old
  - 2 – 7.5%
  - Prevalence decreases to less than 1% in children 6+ years old

# Barriers to Plant-Based Alternatives

- Vegetarian Diet Barriers
  - Enjoyment of meat
  - Convenience
  - Information barriers
- Plant-Based Meat Alternative Barriers
  - Food neophobia
  - Sensory attributes
  - Lack of trust in food manufacturers

Appetite. 2017 Feb 1;109:40-47.  
Foods; 2020; 10: 24.

# **Plant-Based Protein and Health**



# Type 2 Diabetes Risk

- Replacing red meat with other protein sources, including plant-based sources associated with reduced risk (Am J Clin Nutr 2021; 113: 612-621)
- Vegans, lacto-ovo vegetarians, and semi-vegetarians had a lower risk of type 2 diabetes than nonvegetarians. (Diabetes Care 2009; 32: 791-796)
- Diets low in carbohydrate but high in plant-based protein associated with lower risk (Am J Clin Nutr 2008; 87: 339-346)

# Cardiovascular Disease Risk

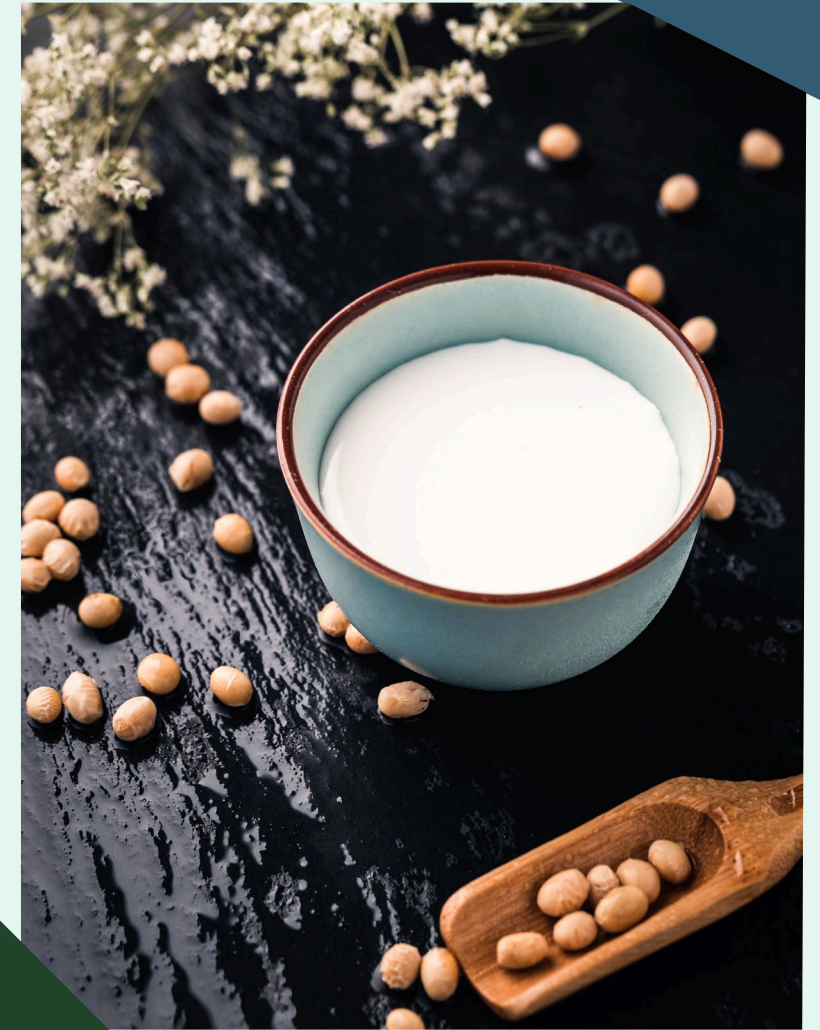
- Compared to red meat consumption plant-based diets associated with lower total and LDL cholesterol (Circulation 2019; 139: 1828-1845)
- Plant-based diets high in whole grains, fruits/vegetables, legumes, nuts, and healthy oils linked to lower risk of developing coronary heart disease (J Am Coll Cardiol 201; 70: 411-422)

# Overall and Cause-Specific Mortality

- Study of over 400,000 individuals between 1995 and 2011
- Plant protein intake associated with:
  - Lower overall mortality in men and women
  - Lower mortality from cardiovascular disease and stroke
- Not associated with mortality from heart attack, cancer, respiratory disease, infections
- Modeling analysis substituting 3% of calories from animal protein with plant protein significantly associated with lower overall mortality.

JAMA Intern Med. 2020;180:1173–1184.

# Plant-Based Milk Alternatives



# Plant-Based Milk Alternatives

## Definition

“Non-dairy, alternative milk beverages that are derived from plant-based ingredients (e.g., rice, nuts/seeds, coconut, oats, peas, or blends of these ingredients) and often fortified with nutrients found in dairy milk.”

Consensus Statement: Healthy Beverage Consumption in Early Childhood - 2019.  
Robert Wood Johnson Foundation.

# Common Non-Dairy Milks

- Legume milks – soy milk, pea milk
- Grain milks – oat milk, rice milk
- Nut milks – coconut milk, almond milk, cashew milk, hazelnut milk
- Seed milks – hemp milk, flaxseed milk

# How they are made

## Wet Processing

1. Soaked for up to 12 hours, then rinsed and drained
2. Ground to a puree or paste
3. Strained or filtered
4. Heated and homogenized
5. Formulated into beverage by adding water, flavors, vitamins, minerals, oils, sugars, thickeners, stabilizers

## Dry Processing

1. Dried and then milled into flour
2. Processed to separate protein from starch or fiber
3. Formulated into beverage by adding water, flavors, vitamins, minerals, oils, sugars, thickeners, stabilizers

Tara McHugh. How Plant-Based Milks are Processed. Food Technology. 2018.  
[https://www.ift.org/~media/food%20technology/pdf/2018/12/1218\\_col\\_processing.pdf](https://www.ift.org/~media/food%20technology/pdf/2018/12/1218_col_processing.pdf)

# MyPlate Dairy Group

## Why is it important to eat/drink dairy?

Consuming dairy products provides health benefits – especially building and maintaining strong bones. Foods in the Dairy Group provide nutrients that are vital for health and maintenance of your body. These nutrients include **calcium, potassium, vitamin D, and protein.**

Eat Healthy – Dairy, MyPlate website. <https://www.myplate.gov/eat-healthy/dairy>



Milk Alternative (1 cup)	Calories (kcal)	Fat (g)	Sat Fat (g)	Calcium (mg)	Vit D (IU)	Potassium (mg)	Protein (g)	Sugar
Cow's milk (1%)	106	2	1.5	300	101	379	8	11
Almond milk (So Delicious)	40	3	0	450	101	190	1	1
Cashew milk (Pacific Foods)	50	4	1	47	0	51	0	2
Coconut milk (Silk)	45	4	3.5	450	80	310	0	0.5
Flaxseed milk (Good Karma)	25	2.5	0	280	92	0	0	0
Hazelnut milk (Pacific Foods)	30	3	0	0	0	118	1	0
Hemp milk (Pacific Foods)	60	4.5	0	257	80	100	3	0
Rice milk (Rice Dream)	120	2.5	0	20	0	0	1	10
Oat milk (Oatley)	120	5	0.5	250	144	390	3	7
Soy milk (Silk)	110	4	0.5	300	120	259	7	6
Pea milk (Ripple)	90	4.5	0	465	240	450	8	5

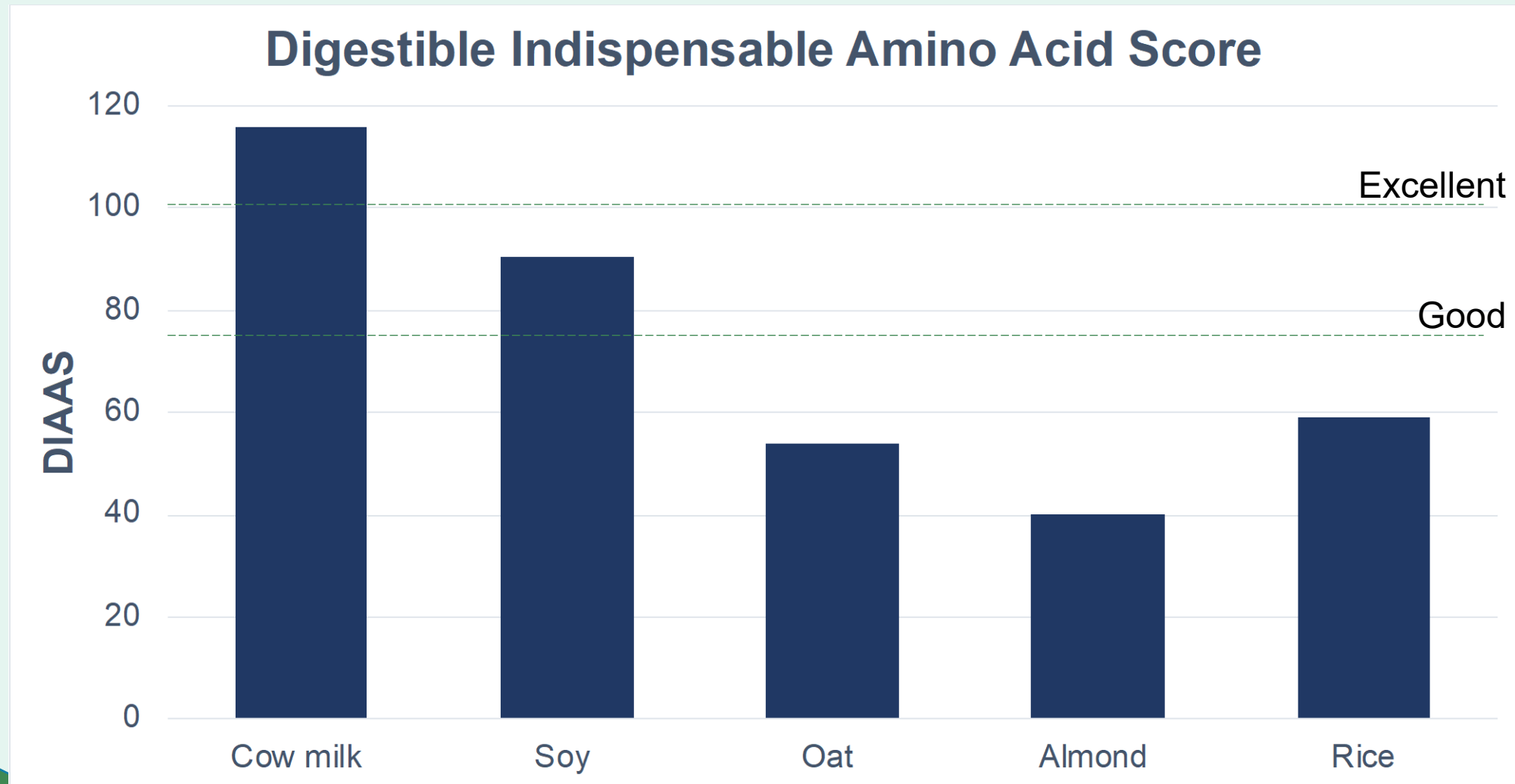
Mention of products is for informational purposes and does not constitute endorsement or promotion of a particular item.

# Protein Quality

- Measured with Digestible Indispensable Amino Acid Score (DIAAS)
  - Compares the amount of digestible dietary indispensable amino acid to a reference protein
  - Different reference proteins by age group (Birth – 6 mo, 6 mo – 3 yr, 3 yr and above)
- Nutrition claims based on scores
  - Excellent/High  $\geq 100$
  - Good/Source = 75 – 99

FAO. Dietary Protein Quality Evaluation in Human Nutrition: Report of an FAO Expert Consultation; FAO: Rome, Italy, 2013; Volume 92.

# DIAAS for Plant-Based Milks



# Health Drawbacks

- Bioavailability of micronutrients
  - May contain phytates and oxalate
- Added sugar
- Displacement of more nutrient-dense beverages in infants and young children (exception of soy milk)
  - Infants should only consume human milk or iron-fortified formula during first year of life
  - Plant milks (other than soy milk) not recommended for young children

# Infants and Young Children

- 30 documented cases of severe nutritional deficiencies in infants and toddlers who consumed plant-based beverages exclusively or with complementary foods
  - Rickets
  - Kwashiorkor (protein malnutrition)
  - Metabolic alkalosis
  - Failure to thrive

Technical Scientific Report: Healthy Beverage Consumption in Early Childhood.  
2019. Robert Wood Johnson Foundation

# Dietary Guidelines on Plant-Based Milks

- Only fortified soy milk and soy yogurt are considered to contribute to the dairy group recommendation due to nutrient composition
- Other plant milks are not included in the dairy group because overall nutrient content is not similar enough to dairy, even when fortified with calcium.

# Nutritional Equivalency Child Nutrition Programs

- National School Lunch Program, School Breakfast Program, Child and Adult Care Food Program
  - Non-dairy fluid milk substitutions fortified in accordance with guidelines issued by the FDA that meet minimums for nine specified nutrients
- WIC Food Packages
  - Allowable fluid milk substitution options: yogurt, cheese, soy beverage, and tofu.

Milk Requirements in the Child Nutrition Programs. California Department of Education. April 13, 2021. <https://www.cde.ca.gov/ls/nu/he/milkrequirementsincnps.asp>

Snapshot - Food Packages for Women, Infants, and Children. WIC Works Resource System, USDA. October, 2019. <https://wicworks.fns.usda.gov/resources/snapshot-food-packages-women-infants-and-children>

# **Plant-Based Meat Alternatives**



# Traditional vs Novel Plant-based Meat Alternatives

## Traditional

- Tofu
- Tempeh
- Seitan
- Jackfruit

## Novel

- Textured plant proteins
- Mycoprotein (Quorn)
- Impossible Meat
- Beyond Meat

**Traditional**

# Tofu

- Also called bean curd or soybean curd
- First developed in China over 2000 years ago
- Made by heating and adding coagulant to soy milk and then pressing out liquid
- Several varieties that vary by firmness



# Tempeh/Tempe

- Soybeans fermented with *Rhizopus* fungi
- Originated in Indonesia over 300 years ago
- Meaty, mushroom-like, nutty flavor



# Seitan

- Made from vital wheat gluten
- First documented production over 1500 years ago
- Chewy texture
- Often sold pre-seasoned



# Jackfruit

- Part of traditional cuisine in South Asia and Southeast Asia
- Can consume the fruit and seeds
- Different uses for unripe and fully ripe jackfruit



# **Novel Plant-Based Meat Alternatives**

# Novel Plant-Based Meat Production



Protein isolation and functionalization – target protein for meat alternative is identified



Formulation – other ingredients are added to improve texture, appearance, nutrient profile



Processing – mixture is reshaped to form a meat-like texture

Nature Communications 2020, 11:6276

California's CalFresh Healthy Living, with funding from the United States Department of Agriculture's Supplemental Nutrition Assistance Program – USDA SNAP, produced this material. These institutions are equal opportunity providers and employers. For important nutrition information, visit [www.CalFreshHealthyLiving.org](http://www.CalFreshHealthyLiving.org).



# Textured Plant Proteins

- Refers to variety of different products intended to mimic meat products
  - Deli meat, sausage, bacon, ground meat, meat loaf, fish, chicken, etc.
- Usually soy-based
- Nutrient content varies by product, but often high in sodium



# Mycoprotein (Quorn)

- Protein source – *Fusarium venenatum* fungus
- Designated Generally Recognized as Safe (GRAS) by FDA in 2002
- Over 20 different products, including chicken nuggets, ground meat, turkey roast, lasagna, chicken patties, fish sticks
- Most products contain egg white as a binder

Quorn Website. <https://www.quorn.us/>

# Beyond Meat

- Protein source – peas, beans
- Products include burger, ground beef, sausage, meatballs, breakfast sausage, beef crumbles, chicken strips
- Beet juice and apple extract to mimic taste and appearance of meat

Beyond Meat Website; <https://www.beyondmeat.com>

Mention of products is for informational purposes and does not constitute endorsement or promotion of a particular item.

# Impossible Meat

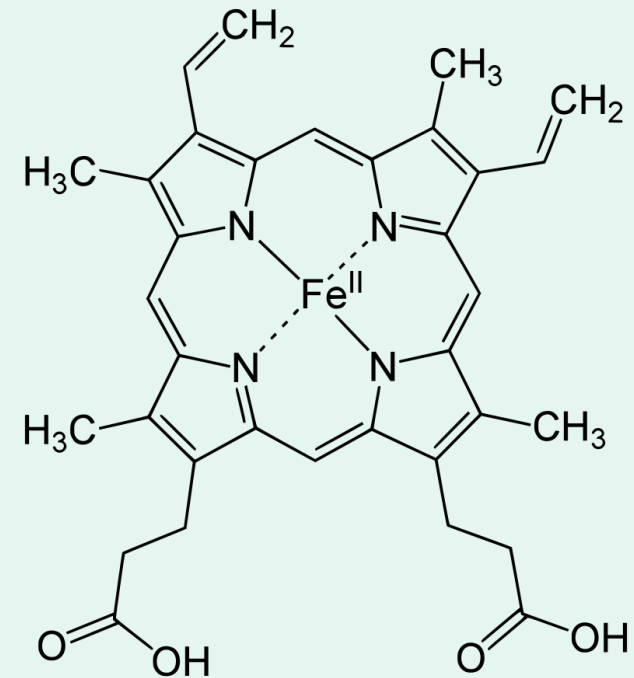
- Protein source – soy
- Products include burger, sausage, pork, chicken nuggets
- Contains leghemoglobin - helps mimic taste, appearance of ground beef

Impossible Foods Website; <https://impossiblefoods.com>

Mention of products is for informational purposes and does not constitute endorsement or promotion of a particular item.

# Heme Proteins

- Hemoglobin and myoglobin
- Leghemoglobin
  - Produced in root nodules of soy bean plants
  - Impossible meat – leghemoglobin produced by genetically modified yeast
    - Allows for scaled-up production



Food	Calories	Total Fat	Sat. Fat	Cholesterol	Sodium	Total Carb	Fiber	Sugars	Protein	Calcium	Iron	Potassium
Ground Beef (80% lean, 20% fat)	287	23	9	80	75	0	0	0	19	20	2	305
Tofu Extra Firm (Vitasoy)	99	5	1	0	29	2	1	1	11	199	2	118
Tempeh (Nature's Promise)	253	10	2	0	0	15	6	2	27	106	2	505
Seitan Strips (Sweet Earth)	163	4	0	0	425	8	0	1	28	30	3	125
Jackfruit (Upton's Naturals)	30	0	0	0	23	8	5	1	2	76	1	166
Mycoprotein Burger (Quorn)	184	10	4	7	650	11	4	1	14	210	0	192
Soy Ground Beef (Gardein)	156	3	0	0	468	9	6	1	23	104	3	688
Impossible Burger (Impossible Foods)	240	14	8	0	370	9	3	1	19	170	4	610
Beyond Burger (Beyond Meat)	230	14	5	0	390	7	2	0	20	8	4	330

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# Novel Plant-Based Beef

- Primarily driven by environmental concerns rather than health
- Focus on mimicking taste, texture, and appearance of meat to appeal more to meat eaters
- “Our whole focus is on making products that deliver everything that meat lovers care about,” Pat Brown, Impossible Foods CEO.

Nathaniel Popper. Behold the Beefless Impossible Whopper. April 1, 2019. NY Times.  
<https://www.nytimes.com/2019/04/01/technology/burger-king-impossible-whopper.html>

# SWAP-MEAT Study

- Investigated impacts of 8 weeks of plant-based meat (Beyond Meat) and 8 weeks of animal meat on TMAO levels (n=36)
  - Order randomly assigned
  - Blood levels measured every two weeks
- Increase in TMAO during 8 weeks of animal meat consumption **only** when it preceded plant-based meat consumption
- Limitations
  - Small sample size
  - No wash-out period



# Metabolomics Comparison of Plant-Based Meat and Grass-Fed Beef

- Study comparing the content of 171 different compounds with anti-oxidant or other health properties in grass-fed beef versus a plant-based meat alternative
  - Plant-based meat alternative product contained leghemoglobin
- Despite similar Nutrition Facts label, substantial differences detected
  - Beef contained 22 compounds not found in the plant-based product and 51 in greater amount
  - Plant-based product 31 compounds not found in beef, and 51 in greater amounts than beef

Sci Rep. 2021;11:13828.

# Commentary in Nutrition and Health Journals

- Advocate caution in applying the health benefits of plant-based diets to novel meat alternatives high in saturated fat and sodium
- Concern that plant-based meat alternatives being consumed primarily as fast food with refined grains and sugar-sweetened beverages
- Additional evidence is needed on specific products
- Important to continue public health recommendations for dietary patterns rich in fruits, vegetables, whole grains, legumes, nuts and seeds

JAMA. 2019;322:1547–1548.

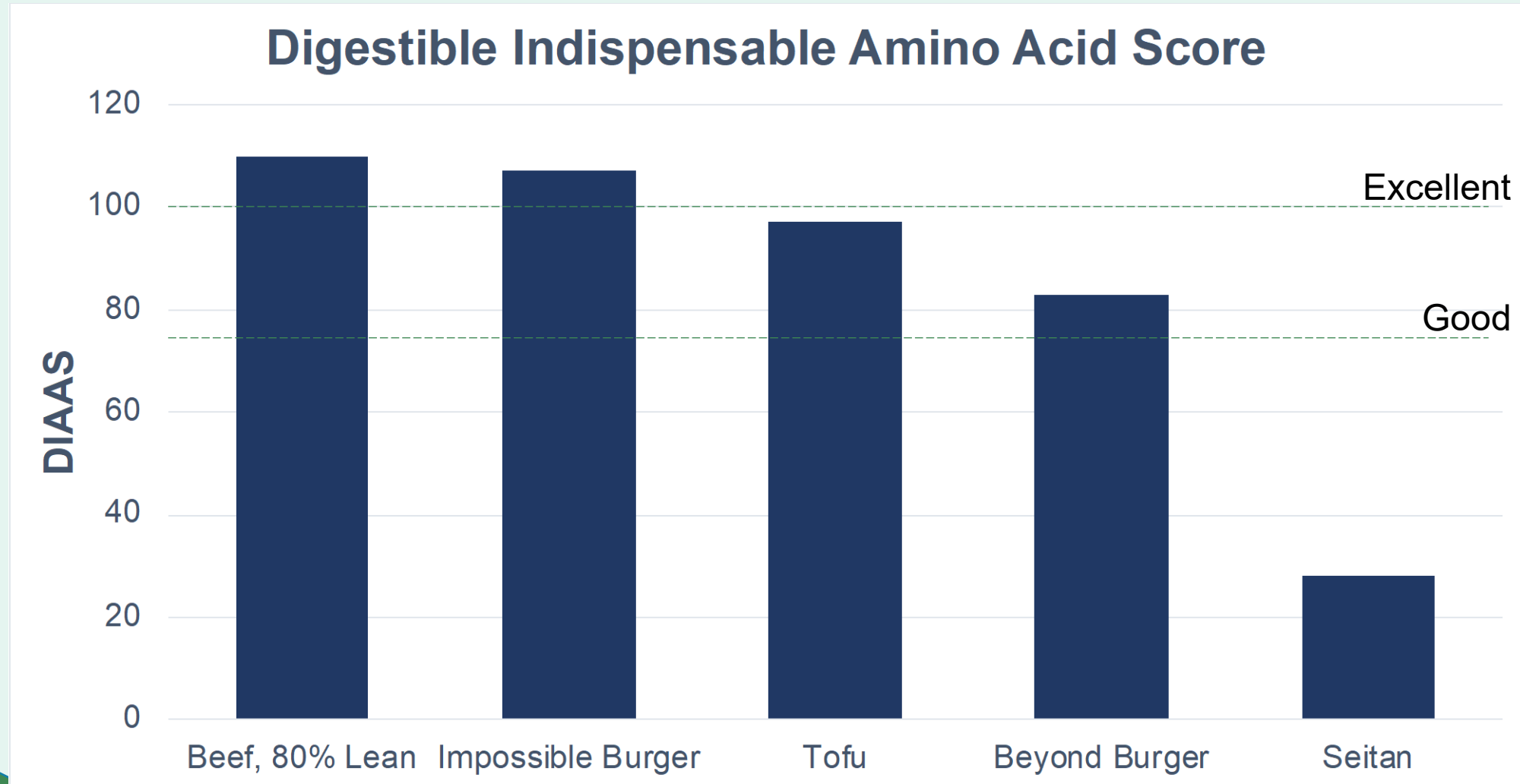
J Nutr. 2021;151:1-2.

Am J Clin Nutr. 2020 ;112:1151-1152.

# Concerns Regarding Novel Plant-Based Meat Alternatives

- Bioavailability of micronutrients
  - May contain phytates and oxalate
- High sodium and saturated fat
- Lower protein quality
- Allergy concerns
- Heme iron linked to type 2 diabetes
- Soy foods and phytoestrogens
- Products considered ultra-processed foods
- High cost of products

# DIAAS for Plant-Based Protein



# Allergy Concerns

- Soy – Tofu, tempeh, Impossible products, most textured plant protein products
- Wheat and gluten – Seitan, some Quorn products, some Beyond products, some Impossible products, some textured plant protein products
- Egg – Some Quorn products

# Mycoprotein and Allergies

- Reports of adverse reactions to mycoprotein products
  - Gastrointestinal distress
  - Allergic reactions
- Alleged to be unsafe by consumer advocacy group Center for Science in the Public Interest
- Response by Quorn on their website about this issue
- Symposium at American Society for Nutrition Conference
  - Discussed safety and concluded that allergic reactions are very rare – 1 in 9 million packages

Can I Be Intolerant or Allergic to Quorn? Quorn Website.  
<https://www.quorn.us/intolerance>  
Curr Dev Nutr. 2019;3:nzz021.

# Heme Iron and Type 2 Diabetes

- Systematic review and meta-analysis of 11 studies
- Those with the highest level of heme iron intake 33% greater risk of type 2 diabetes compared to those with lowest intake
- No significant associated between total dietary iron, non-heme iron, or supplemental iron and type 2 diabetes

BMC Med 2012; 10: 119.

# Soy Foods and Phytoestrogens

- Soy contains isoflavones which has a structure similar to estrogen
- Concerns about impacts on hormone levels, earlier onset of puberty not supported by research
- “There is no conclusive evidence from animal, adult human, or infant populations that dietary soy isoflavones may adversely affect human development, reproduction, or endocrine function.”

Nutrients, 2016; 8(12): 754  
Pediatrics, 2008; 121(5): 1062-8



# Ultra-processed Foods

- Recent trend in “clean label” foods
  - Minimally processed
  - Contain recognizable ingredients
- Concern among consumers over novel plant-based meat alternatives as ultra-processed foods

# NOVA Classification

1. Unprocessed and minimally processed foods
2. Processed culinary ingredients
3. Ready-to-consume products
  - 3.1 Processed food products
  - 3.2 Ultra-processed products



Curr Obes Rep. 2014;3:256-72.

# Cost Considerations

	Ground Beef (80/20)	Quorn Meatless Gourmet Burger	Impossible Ground Beef	Beyond Beef	Mindful Chik'n	Tofu	Tempeh
Package Price	6.19	3.99	7.99	9.99	6.99	2.49	4.49
Ounces	16	11.3	12	16	8	16	8
Price per pound	6.19	7.07	10.66	9.99	13.98	2.49	8.98

Mention of products is for informational purposes and does not constitute endorsement or promotion of a particular item.

# **Key Takeaways**

# Overall Dietary Pattern

- Individual foods should be considered in the context of the overall dietary pattern
- Meet nutritional needs through a balanced diet of nutrient-dense foods

# Choosing Nutritionally-Equivalent Products

- When replacing an important food source of nutrients, replacement should be nutritionally equivalent
- Example –
  - Fortified soy milk as a replacement for cow's milk

# Responding to Misinformation

**A friend told me that men and boys shouldn't eat soy because it has estrogen.**

## **Affirm/Reflect**

That subject is getting a lot of attention in the media.  
You are naturally concerned about your family's health.

## **Offer correct information**

Let's talk about what the science says...

## **Thank/Move On**

Thank you for your comments and for the chance to provide the group more information.  
Now let's go to the next activity...

# Thank you!