Building a Foundation for Closing the Dietary Fiber Gap: Improving Gut Health through a Diverse Diet

April 22, 2021

Presenter:
Henry J. Thompson, PhD
Professor
Director of the Cancer Prevention Laboratory
Colorado State University

Moderator:
Barbara J. Ivens, MS, RDN, FADA, FAND

Approved for 1 CPE (Level 2) by the Commission on Dietetic Registration

Bean Academy webinars

The Michigan Bean Commission (MBC) is pleased to offer a series of free accredited webinars, many with a plant-forward eating focus, that cover a broad range of contemporary nutrition and food topics.

Webinars are a blend of research, science and practice to help nutrition professionals stay informed on recent developments on relevant topics.

Webinars are funded as part of a 2020-2021 USDA grant to the Michigan Bean Commission.

Webinar logistics

- A Handout of the slides presented today is available at: https://MichiganBean.com/hp-webinar-thompson-presn
- The Continuing Education Credit certificate is available to download after the webinar: https://MichiganBean.com/hp-webinar-thompson-ceu
- The presenter will answer questions at the end of this webinar. Please submit questions by using the 'Q&A' feature on your computer screen.

Today's Faculty

- **Henry J. Thompson, Ph.D.**
  - Professor, Nutrien Distinguished Scholar of Agricultural Sciences in the College of Agricultural Sciences, Colorado State University
  - Director of the Cancer Prevention Laboratory, Colorado State University
- Moderator:

Barbara J. Ivens, MS, RDN, FADA, FAND – Consultant, Michigan Bean Commission

Learning Objectives

Upon completion of this webinar participants will be able to:

- Describe what pulses are and how to properly categorize them
- Discuss the health benefits of pulse consumption
- Explain what critical thinking is and how to use the process to develop workable solutions to health improvement via increased pulse consumption

Building a Foundation for Closing the Dietary Fiber Gap: Improving Gut Health through a Diverse Diet

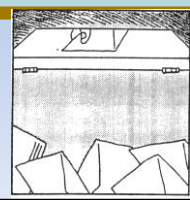
Henry J. Thompson
Cancer Prevention Laboratory
Colorado State University, Fort Collins, CO
henry.thompson@colostate.edu

Learning Objectives

Upon completion of this webinar participants will be able to:

- Describe a framework for assessing plant food diversity of the diet.
- Discuss what pulses are, how to properly categorize them, and the health benefits of pulse consumption.
- Explain what critical thinking is and how to use the process to develop workable solutions to health improvement via increased pulse consumption

Let's build your tool kit
What is the future of dietary diversity, gut health, and human health & wellness?



What is Critical Thinking?

Take unstructured information; Structure that information; Do something with it.

Dietary diversity; Dietary Fiber; Gut Health; Obesity

Making **Distinctions** – which consist of an *identity* and an *other:* What is _____?;What is not _____?

Organizing **Systems** – which consists of *part* and *whole:* Does _____ have parts? Can you think of _____ as a part?

Recognizing **Relationships** – which consist of *action* and *reaction:* Is _____ related to _____?; Can you think of _____ as a relationship?

Taking **Perspectives** – which consist of *point* and *view:* From the perspective of _____, [insert question]?; Can you think about _____ from a different point of view?

Derek Cabrera:https://www.youtube.com/watch?v=dUqRTWCdXt4

What does Gut Health look like?

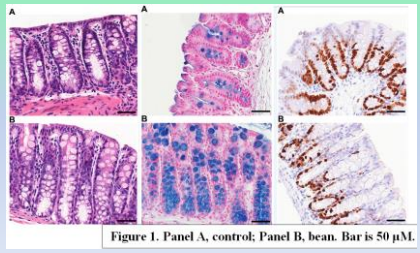
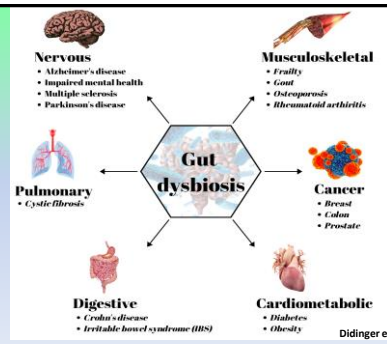
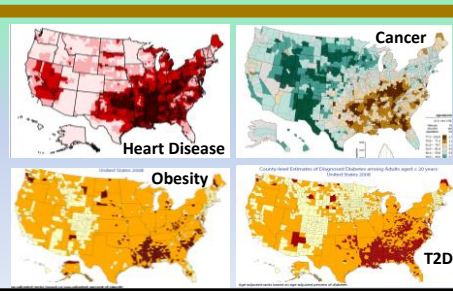


Figure 1. Panel A, control; Panel B, bean. Bar is 50 μM.



Didinger et al. 2021

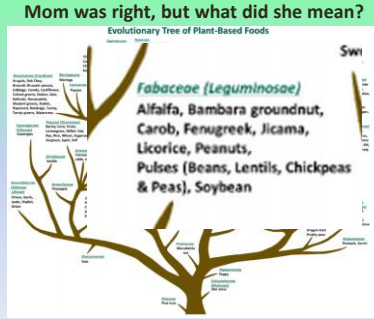
The Inter-Relatedness of Chronic Diseases



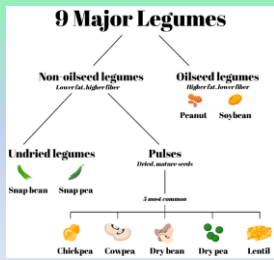
Improved gut health via pulse consumption: on relationships

Didinger et al 2021

Mom was right, but what did she mean?



What are pulses?



What distinguishes pulses from other legumes?

Table 1. Nutritional analysis of 100 kilocalorie portions of the predominant pulses, undried legumes, and oilseed legumes.

	Chickpea	Cowpea	Dry Bean	Snap Bean	Dry Pea	Green Pea	Snap Pea	Lentil	Peanut	Soybean	Edamame
Approximate Amount	~1/3 cup	~1/2 cup	~1/2-1/3 cup	~3 cups	~1/2 cup	~1 cup	~2.5 cups	~1/2 cup	~ 2 Tbs	~1/3 cup	~1/2 cup
Protein (g)	5.4	6.7	6.7	5.4	7.2	6.4	5.7	7.8	4.6	10.6	7.8
Total Lipid (g)	1.6	0.5	0.4	0.8	0.3	0.3	0.0	0.3	8.7	5.2	2.8
Carbohydrate (g)	16.7	17.9	18.0	22.5	17.7	18.6	17.2	17.4	2.8	4.9	11.1
Dietary Fiber (g)	4.6	5.6	6.6	9.1	7.2	6.5	5.9	6.8	1.5	3.5	3.4
Folate (µg)	104.9	179.3	112.9	94.3	56.0	75.0	MV	156.0	42.3	31.4	MV

Aren't pulses just another vegetable?

Table 2. Nutritional analysis of 100 kilocalorie portions of dry bean versus other vegetable subgroups.

	Dry Bean	Cassava	Potato	Carrots	Broccoli	Cucumber
Approximate Amount	~1/2-1/3 cup	~1/3 cup	~2/3 cup	~1.75 cups	~ 2 cups	~5 cups
Protein (g)	6.7	2.7	2.7	2.2	8.4	4.3
Total Lipid (g)	0.4	0.7	0.1	0.5	1.1	0.7
Carbohydrate (g)	18.0	22.6	22.7	23.5	19.7	24.2
Dietary Fiber (g)	6.6	0.7	2.4	8.6	7.7	3.3
Folate (µg)	112.9	MV	30.1	40.0	160.0	46.7

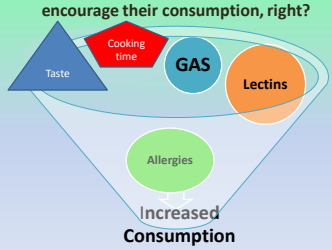
Pulses are just a meat alternative, right?

Table 3. Nutritional analysis of 100 kilocalorie portions of dry bean versus other protein foods.

	Dry Bean	Chicken Breast, Skin not Eaten	80/20 Ground Beef	Hard-Boiled Egg	Salmon	Almonds, Unroasted	Tofu
Approximate Amount	~1/2-1/3 cup	~2-oz.	~1.3-oz.	~1.25 eggs	~2-oz.	~2 Tbs	~3.5-oz.
Protein (g)	6.7	16.8	8.1	8.1	16.1	3.7	10.0
Total Lipid (g)	0.4	3.1	5.6	6.8	3.5	8.6	5.6
Carbohydrate (g)	18.0	0.0	0.0	0.7	0.1	3.7	2.5
Dietary Fiber (g)	6.6	0.0	0.0	0.0	0.0	2.2	2.6
Folate (µg)	112.9	4.0	3.1	28.4	3.1	7.6	MV

But with pulses you can't eat your colors; really?

Pulses are just too much of a problem to prepare and eat for us to encourage their consumption, right?



What is dietary fiber?

TABLE 2 Summary of chemical characteristics of dietary fiber in foods[1]

Main components	Dietary fiber characteristic				
	Insoluble dietary fiber	Soluble dietary fiber	Fermentable	Viscous	Polymer type
Cellulose	HMW				Glucan
Lignin	HMW				Monolignol
Resistant starch		HMW[2]	X	X	Type 1, 2, 3, 4
Hemicelluloses	HMW	HMW[2]	X	X	Xylan, galactan, araban, mannan, others
Pectins	HMW	HMW[2]	X	X	Galacturonic acid
Arabinoxylans		HMW[2]	X	X	Xylan
β-Glucans		HMW[2]	X	X	Glucan
Gums		HMW[2]	X	X	Mannan
Mucilages		HMW[2]		X	
Inulin		LMW	X		Fructan
Fructooligosaccharides (nystose, kestose)		LMW	X		Fructan
Galactooligosaccharides (raffinose family)		LMW	X		Raffinose family

[1] HMW, high molecular weight; LMW, low molecular weight; X, the main component has the identified characteristic.
[2] Soluble in aqueous solution but precipitates in 80% ethanol (vol/vol).

LET'S BE REAL: THE DIETARY FIBER GAP IS INSURMONTABLE; TAKE A FIBER SUPPLEMENT IF YOU ARE CONSTIPATED!

- **Dietary fiber intake for Americans is 12-16g/d, which is far from the requirement which is 28-42g/d; 95% Americans fail**

TABLE 4 Dietary fiber intake of pulse crop by consumers and nonconsumers

Dietary fiber intake	Nonconsumers[1]	High consumers[1]	Nonconsumers[2]	High consumers[2]
Cereal grains, servings/d	6.5	6.4	5.8	6.3
Pulse grains, g/d	0	277	0	294
Protein, g/d	80	106	85	101
Fiber, g/d	14	36	17	31
Fiber, g/4184 kJ	7.0	13.6	8.5	13.8

[1] Data shown are from reference 14.
[2] Data shown are from reference 15.

Effect of pulses on the gut microbiome

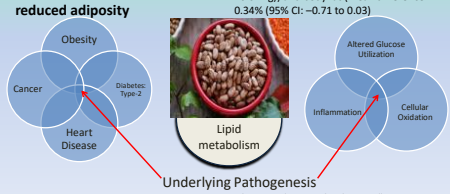
Microbiota	Bean	Chickpea	Dry Pea	High Fat	Lentil	Low Fat	*Total:*
Muribaculaceae	46,127	44,968	44,980	17,972	45,731	42,767	242,534.00
Clostridiales sp.	28,330	28,328	35,101	39,575	14,529	16,833	162,693.75
Bacteroides acidifaciens	26,419	22,023	37,304	6,336	46,216	10,853	149,209.75
Rikenellaceae sp.	23,974	28,454	29,567	3,499	24,231	32,691	142,415.25
Clostridiales	15,275	13,254	13,308	17,608	10,888	56,477	126,809.00
Oscillospira sp.	6,693	15,758	14,521	12,569	12,167	18,460	101,257.00
Desulfovibrionaceae sp.	18	32	48	90,531	42	46	90,716.25
Bacteroidales sp.	2,908	23,916	18	3	29,149	8	55,990.50
Bacteroides	1,884	6,439	5,710	15,155	1,747	18,986	49,919.75
Allobaculum sp.	2,495	8,824	2,451	3	6,997	3,269	24,038.00
Dorea sp.	75	266	391	3,052	751	10,295	14,830.00
[Ruminococcus] gnavus	563	1,345	1,390	5,794	810	4,743	14,643.75
Akkermansia muciniphila	4,342	197	97	2,324	7,341	67	14,367.50
Lactobacillus sp.	3	83	7	191	19	7,671	7,973.50
Clostridium methylpentosum	370	205	272	2,181	745	2,958	6,730.00
Butyricicoccus pullicaecorum	254	4,379	729	65	1,273	24	6,722.50
Mucispirillum schaedleri	157	301	803	2,237	476	1,557	5,531.25
Dehalobacterium	600	623	393	1,029	480	1,411	4,535.00
Sutterella sp.	979	811	323	16	2,024	10	4,162.50
Clostridium	82	117	15	14	16	3,702	3,944.75
Lactococcus sp.	66	97	140	1,001	89	1,052	2,444.50
Bifidobacterium pseudolongum	3	3	3	3	3	2,282	2,296.50
Turicibacter sp.	3	45	31	3	3	1,733	1,818.00
Clostridiaceae	3	3	3	3	3	1,500	1,514.50
[Mogibacteriaceae] sp.	290	133	340	58	410	100	1,329.50
Christensenellaceae sp.	8	3	8	668	11	369	1,066.00
Peptococcaceae rc4-4 sp.	385	40	89	3	406	3	926.25
Clostridium sp.	357	115	42	3	3	45	564.25
Clostridium colinum	48	13	268	3	3	3	357.75
Alphaproteobacteria RF32 sp.	31	126	62	3	118	3	341.75
Roseburia	38	28	219	3	3	3	293.50
Peptostreptococcaceae sp.	8	15	142	3	3	10	181.25
Anaeroplasma sp.	3	3	3	8	3	70	89.50
Anaerotruncus sp.	3	3	3	45	3	3	59.50

Clinical evidence

Viguiliouk, E., 2017

Systematic review and meta-analysis of 21 randomized controlled clinical trials, pulse consumption was associated with **improved weight control and reduced adiposity**

Dietary pulses at a **median dose of 132 g/day** were found to lower body weight (mean difference = −0.34 kg (95% CI: −0.63 to −0.04 kg)) and body fat (mean difference = −0.34% (95% CI: −0.71 to 0.03)



Thompson et al, 2009; Hirsch et al. Cancer Cell: 2010

Paired-feeding of commercially processed bean powder

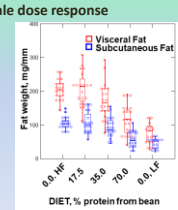
The magnitude of the difference in total visceral adiposity between control and bean fed rats was 27.8% in the OS rat strain and 43.4% in the OR rat strain.

Diet [1]	Final body weight (g)	Feed efficiency ratio (g)	Retro-peritoneal fat [2] (mg/mm)	Para-metrial fat (mg/mm)	Peri-renal fat (mg/mm)	Total visceral fat (mg/mm)
	Obesity Sensitive (OS)					
Control	230	0.321	77.1	185.6	25.9	288.6
Bean	226	0.323	67.5	136.9	13.8	218.2
	Obesity Resistant (OR)					
Control	166	0.251	38.5	88.2	14.2	140.8
Bean	164	0.260	25.1	59.9	5.7	90.7

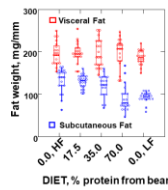
[1] Values are means ± SEM; [2] Units are mg mass divided by length of tibia in mm; [3] For factorial ANOVA, Strain is OR vs OS, Diet is Control vs Bean; OS Control n=7, OS Bean n=7, OR Control n=6, OR Bean n=6.

It's all about the dose

Female dose response



Male dose response



Use it or lose it: 7 in 10!

The facts

	Chickpea	Cowpea	Dry Bean
Approximate Amount	~1/3 cup	~1/2 cup	~1/2-1/3 cup
Protein (g)	5.4	6.7	6.7
Total Lipid (g)	1.6	0.5	0.4
Carbohydrate (g)	16.7	17.9	18.0
Dietary Fiber (g)	4.6	5.6	6.6

Put the information to use

- DRI: protein 60g/d
- 70% DRI Pr= 49g
- If bean: 49/7=2.3C=700kcal
- And 49g dietary fiber
- The dietary fiber gap is "crushed"!

Critical Thinking/Problem Solving

Key Takeaways

- A high quality healthy diverse diet: whole food maximized
  - High botanical diversity score (think the tree)
  - Rich in pulses
- Dietary fiber-gut health-human health: mind the gap!
- Dose matters (49g protein, 49g fiber, 700kcal)
  - It's easy, safe, affordable…and I like it!

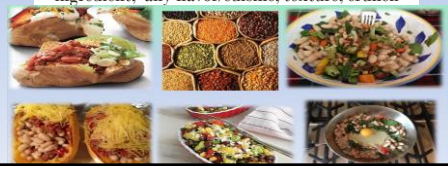
The bottom line

Common Bean and Other Pulses

The **Premiere**, **Authentic**, Low Fat, High Fiber, High Protein **ANTI-OBESOGENIC** Foods: Non GMO, Gluten Free, No cholesterol

The Secret of the "Ancients" Rediscovered

Culinary flexibility: whole food, whole powder, ingredient, any flavor/cuisine, texture, crunch



References

- Thompson, H.J.; Levitt, J.O.; McGinley, J.N.; Chandler, P.; Guenther, P.M.; Huybrechts, I.; Playdon, M.C. Measuring Dietary Botanical Diversity as a Proxy for Phytochemical Exposure. Nutrients **2021**, *13*, 1295.
- Didinger, C. & Thompson, H. J. Defining Nutritional and Functional Niches of Legumes: A Call for Clarity to Distinguish a Future Role for Pulses in the Dietary Guidelines for Americans. *Nutrients* **13**, doi:10.3390/nu13041100 (2021).
- McGinley, J. N. *et al.* Pulse Crop Effects on Gut Microbial Populations, Intestinal Function, and Adiposity in a Mouse Model of Diet-Induced Obesity. *Nutrients* **12**, doi:10.3390/nu12030593 (2020).
- Didinger, C. & Thompson, H. Motivating Pulse-Centric Eating Patterns to Benefit Human and Environmental Well-Being. *Nutrients* **12**, doi:10.3390/nu12113500 (2020).
- Thompson, H. J. Improving Human Dietary Choices Through Understanding of the Tolerance and Toxicity of Pulse Crop Constituents. *Curr Opin Food Sci* **30**, 93-97, doi:10.1016/j.cofs.2019.01.001 (2019).
- Thompson, H. J. Dietary Bean Consumption and Human Health. *Nutrients* **11**, doi:10.3390/nu11123074 (2019).
- Neil, E. S. *et al.* White Kidney Bean (Phaseolus Vulgaris L.) Consumption Reduces Fat Accumulation in a Polygenic Mouse Model of Obesity. *Nutrients* **11**, doi:10.3390/nu11112780 (2019).
- Myers, J. R. *et al.* Improving the Health Benefits of Snap Bean: Genome-Wide Association Studies of Total Phenolic Content. *Nutrients* **11**, doi:10.3390/nu11102509 (2019).

References

- Moghaddam, S. M. *et al.* Genetic Architecture of Dietary Fiber and Oligosaccharide Content in a Middle American Panel of Edible Dry Bean. *Plant Genome* **11**, doi:10.3835/plantgenome2017.08.0074 (2018).
- Thompson, H. J., McGinley, J. N., Neil, E. S. & Brick, M. A. Beneficial Effects of Common Bean on Adiposity and Lipid Metabolism. *Nutrients* **9**, doi:10.3390/nu9090998 (2017).
- Wiesinger, J. A. *et al.* Demonstrating a Nutritional Advantage to the Fast-Cooking Dry Bean (Phaseolus vulgaris L.). *J Agric Food Chem* **64**, 8592-8603, doi:10.1021/acs.jafc.6b03100 (2016).
- Thompson, H. J. & Brick, M. A. Perspective: Closing the Dietary Fiber Gap: An Ancient Solution for a 21st Century Problem. *Adv Nutr* **7**, 623-626, doi:10.3945/an.115.009696 (2016).
- Chen, Y., McGee, R., Vandemark, G., Brick, M. & Thompson, H. J. Dietary Fiber Analysis of Four Pulses Using AOAC 2011.25: Implications for Human Health. *Nutrients* **8**, doi:10.3390/nu8120829 (2016).
- Kleintop, A. E., Echeverria, D., Brick, L. A., Thompson, H. J. & Brick, M. A. Adaptation of the AOAC 2011.25 integrated total dietary fiber assay to determine the dietary fiber and oligosaccharide content of dry edible beans. *J Agric Food Chem* **61**, 9719-9726, doi:10.1021/jf403018k (2013).
- Zhu, Z., Jiang, W. & Thompson, H. J. Edible dry bean consumption (Phaseolus vulgaris L.) modulates cardiovascular risk factors and diet-induced obesity in rats and mice. *Br J Nutr* **108 Suppl 1**, S66-73, doi:10.1017/S0007114512000839 (2012).

References

- Thompson, M. D. & Thompson, H. J. Physiological effects of bean (Phaseolus vulgaris L.) consumption on cellular signaling in cancer. *Cell Cycle* **11**, 835-836, doi:10.4161/cc.11.5.19676 (2012).
- Thompson, M. D. *et al.* Cell signaling pathways associated with a reduction in mammary cancer burden by dietary common bean (Phaseolus vulgaris L.). *Carcinogenesis* **33**, 226-232, doi:10.1093/carcin/bgr247 (2012).
- Mensack, M. M., McGinley, J. N. & Thompson, H. J. Metabolomic analysis of the effects of edible dry beans (Phaseolus vulgaris L.) on tissue lipid metabolism and carcinogenesis in rats. *Br J Nutr* **108 Suppl 1**, S155-165, doi:10.1017/S0007114512000827 (2012).
- Daniell, E. L., Ryan, E. P., Brick, M. A. & Thompson, H. J. Dietary dry bean effects on hepatic expression of stress and toxicity-related genes in rats. *Br J Nutr* **108 Suppl 1**, S37-45, doi:10.1017/S0007114512000815 (2012).
- Mensack, M. M. *et al.* Evaluation of diversity among common beans (Phaseolus vulgaris L.) from two centers of domestication using 'omics' technologies. *BMC Genomics* **11**, 686, doi:10.1186/1471-2164-11-686 (2010).
- Mensack, M. M., Fitzgerald, V. K., Lewis, M. R. & Thompson, H. J. Characterization of low molecular weight chemical fractions of dry bean (Phaseolus vulgaris) for bioactivity using Caenorhabditis elegans longevity and metabolite fingerprinting. *J Agric Food Chem* **58**, 6697-6705, doi:10.1021/jf1007538 (2010).
- Thompson, M. D. *et al.* Mechanisms associated with dose-dependent inhibition of rat mammary carcinogenesis by dry bean (Phaseolus vulgaris, L.). *J Nutr* **138**, 2091-2097, doi:10.3945/jn.108.094557 (2008).

Questions?

Henry J. Thompson, PhD
Colorado State University
Fort Collins, CO
henry.thompson@colostate.edu

Building a Foundation for Closing the Dietary Fiber Gap: Improving Gut Health through a Diverse Diet

This webinar covered:

- What pulses are and how to properly categorize them
- Health benefits of pulse consumption
- Critical thinking approach to develop workable solutions to health improvement via increased pulse consumption

MBC Bean Academy webinar details

- Continuing Education Credit certificate is available at: https://MichiganBean.com/hp-webinar-thompson-ceu
- A recording of today's webinar will be available to download at: https://MichiganBean.com/hp-webinar-thompson-presn
- For questions: MBC.BeanAcademy@gmail.com

Next **MBC Bean Academy** Webinar

Anatomy of the Bean: Dry Bean Breeding and Production for Consumer Acceptance

Karen Cichy, PhD
Research Plant Geneticist
USDA, Agriculture Research Service
Michigan State University

Date: June 17, 2021
2-3 pm EDT/1-2 pm CDT/noon MDT
Applied for 1 CPE (Level 2) by the Commission on Dietetic Registration

How are we doing?

- Stay on the line for a brief survey about this **MBC Bean Academy** webinar:

Building a Foundation for Closing the Dietary Fiber Gap: Improving Gut Health through a Diverse Diet

Thank you!