The Role of Plant-Based Proteins in Metabolic Health

Michelle Braun, PhD
Global Protein Scientific Affairs Lead
DuPont Nutrition & Biosciences
Disclosures

• Employee of DuPont Nutrition & Biosciences

• Nutrition researcher

• President of Soy Nutrition Institute
• IFIC, ILSI-NA-Protein Committee, member of ILSI-EU Functional Foods Expert Working Group on Protein
Fruits and vegetable consumption consistently associated with reduced risk of CVD

Meta-analysis of 20 prospective cohort studies¹

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yamaka</td>
<td>2013</td>
<td>0.95 (0.53, 0.98)</td>
</tr>
<tr>
<td>Sharma</td>
<td>2015</td>
<td>0.93 (0.70, 1.10)</td>
</tr>
<tr>
<td>Larsen</td>
<td>2013</td>
<td>0.97 (0.76, 0.97)</td>
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<tr>
<td>Chan (M)</td>
<td>2015</td>
<td>0.90 (0.43, 1.82)</td>
</tr>
<tr>
<td>Chan (F)</td>
<td>2015</td>
<td>0.88 (0.43, 1.82)</td>
</tr>
<tr>
<td>Oude Griep</td>
<td>2015</td>
<td>0.90 (0.63, 1.24)</td>
</tr>
<tr>
<td>Zheng</td>
<td>2011</td>
<td>0.95 (0.75, 1.18)</td>
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<tr>
<td>Yamada (M)</td>
<td>2014</td>
<td>0.90 (0.60, 1.36)</td>
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<tr>
<td>Yamada (F)</td>
<td>2011</td>
<td>0.47 (0.26, 0.87)</td>
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<tr>
<td>Hagura</td>
<td>2009</td>
<td>0.84 (0.61, 1.16)</td>
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<td>Hisahri</td>
<td>2009</td>
<td>0.83 (0.68, 1.03)</td>
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<tr>
<td>Larsen</td>
<td>2009</td>
<td>0.79 (0.72, 0.86)</td>
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<tr>
<td>Rink</td>
<td>2007</td>
<td>0.85 (0.68, 1.07)</td>
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<tr>
<td>Cai</td>
<td>2007</td>
<td>0.85 (0.54, 1.33)</td>
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<tr>
<td>Hess</td>
<td>2006</td>
<td>0.43 (0.26, 0.75)</td>
</tr>
<tr>
<td>Steffen</td>
<td>2003</td>
<td>0.86 (0.54, 1.36)</td>
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<tr>
<td>Sauvaget (M)</td>
<td>2003</td>
<td>0.71 (0.60, 0.83)</td>
</tr>
<tr>
<td>Sauvaget (F)</td>
<td>2003</td>
<td>0.78 (0.60, 0.97)</td>
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<tr>
<td>Johnson</td>
<td>2003</td>
<td>0.72 (0.47, 1.12)</td>
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<tr>
<td>Battman</td>
<td>2002</td>
<td>0.73 (0.67, 0.89)</td>
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<td>Joshipura (M)</td>
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<td>1.74 (0.82, 3.64)</td>
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<td>Joshipura (F)</td>
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<td>0.61 (0.37, 1.00)</td>
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<td>Keli</td>
<td>1990</td>
<td>0.76 (0.48, 1.24)</td>
</tr>
<tr>
<td>Gillman</td>
<td>1990</td>
<td>0.78 (0.57, 1.09)</td>
</tr>
<tr>
<td>Overall</td>
<td></td>
<td>0.79 (0.57, 0.98)</td>
</tr>
</tbody>
</table>

HURT: Weights are from random effects analysis

Increased FV intake associated with 21% reduction in risk of stroke

Meta-analysis of 16 prospective cohort studies²

Dose-response relation between FV intake and risk of all-cause mortality & cardiovascular mortality

## Healthy Eating Recommendations Support Plant-Based Diets

<table>
<thead>
<tr>
<th>Organization</th>
<th>Advice</th>
</tr>
</thead>
<tbody>
<tr>
<td>World Health Organization[4]</td>
<td>Eat a nutritious diet based on a variety of foods originating mainly from plants, rather than animals.</td>
</tr>
<tr>
<td>2015-2020 Dietary Guidelines for Americans, U.S. Department of Health and Human Services[5]</td>
<td>A healthy eating pattern includes a variety of protein foods, including seafood, lean meats and poultry, eggs, legumes (beans and peas), and nuts, seeds and soy products.</td>
</tr>
<tr>
<td>American College of Sports Medicine[6]</td>
<td>A vegetarian diet can be nutritionally adequate containing high intakes of fruits, vegetables, whole grains, nuts, soy products, fiber, phytochemicals and antioxidants.</td>
</tr>
<tr>
<td>Australian Dietary Guidelines[7]</td>
<td>Include some meat-free meals each week – include eggs, legumes such as beans and tofu, and nuts and seeds.</td>
</tr>
<tr>
<td>Eatwell Guide Public Health England[9]</td>
<td>Beans, peas and lentils (which are all types of pulses) are good alternatives to meat, because they're naturally very low in fat, and they're high in fibre, protein, and vitamins and minerals. Other vegetable-based sources of protein include tofu, bean curd and mycoprotein.</td>
</tr>
</tbody>
</table>
Facing a Challenge

Significant evidence that dietary guidelines are not being met in many countries and consumer populations.

Poor dietary quality is contributing to the increasing prevalence of overweight and obesity, diabetes, heart disease.

Poor diet is greatest contributor to total and cardiovascular disease and death worldwide: Global burden of disease attributable to 79 risk factors.

Facing a Challenge

Significant evidence that dietary guidelines are not being met in many countries and consumer populations.

Poor dietary quality is contributing to the increasing prevalence of overweight and obesity, diabetes, heart disease.

Metabolic syndrome (MetS) is estimated to affect at least 25% of adults, globally.

MetS is associated with risk of type 2 diabetes and coronary heart disease.

Lifestyle intervention plays a crucial role in the control & treatment of conditions related to MetS with diet recognized as first strategy.


Factors of Metabolic Syndrome (MetS)

- Blood Pressure
- Liver Health
- Blood Glucose
- Triglyceride concentration
- Abdominal Obesity
- Blood cholesterol concentration

What is the role plant-based diets in addressing these factors? Are plant sources part of the solution?
Consumption of vegetarian diets was associated with reduction in LDL-C of 12.2 mg/dl (p < 0.001) in clinical trials.
Pooled plasma LDL-cholesterol responses to vegetarian diets in clinical trials

Not statistically significant in 9 of 17 trials
What are the key ingredients in a Plant-Based diet to support health?
Nuts and pulses are well-studied

**Daily pulse intake lowers LDL-C**

- Systematic review, meta-analysis of 26 RCTs
- 1 serving/d significantly lowered LDL-C compared to control (5% reduction)

**Daily nut consumption lowers LDL-C**

- Pooled analysis of 25 RCTs
- ~2 servings/d significantly lowered LDL-C compared to control (7.4% reduction)
  - Dose-related
  - Also ↓ LDL/HDL; ↓ TG levels

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**Study** | **Control diet, n** | **Intervention diet, n** | **Mean difference in LDL cholesterol (95% CI), mmol/L** | **Favours dietary pulses** | **Favours dietary control**
--- | --- | --- | --- | --- | ---
Abate et al. | 10 | 10 | -0.06 (-1.17 to 0.05) |  | 
Abayesekara et al. | 80 | 80 | -0.23 (-0.43 to -0.03) |  | 
Anderson et al. | 6 | 6 | -0.17 (-1.89 to 1.55) |  | 
Anderson et al. | 9 | 9 | -0.43 (-1.61 to 0.75) |  | 
Anderson et al. | 9 | 9 | -0.76 (-2.15 to 0.63) |  | 
Anderson et al. | 10 | 10 | -0.25 (-0.86 to 0.36) |  | 
Belkki et al. | 47 | 46 | 0.03 (-0.13 to 0.19) |  | 
Cubasch et al. | 20 | 20 | -0.02 (-0.27 to 0.23) |  | 
Duane et al. | 9 | 9 | -0.31 (-0.56 to 0.06) |  | 
Firley et al. | 42 | 42 | -0.07 (-0.45 to 0.31) |  | 
Firley et al. | 42 | 42 | -0.07 (-0.45 to 0.31) |  | 
Gravel et al. | 42 | 42 | 0.07 (-0.31 to 0.45) |  | 
Hermsdorff et al. | 42 | 42 | -0.07 (-0.46 to 0.32) |  | 
Hodgson et al. | 42 | 42 | 0.07 (-0.31 to 0.45) |  | 
Jenkins et al. | 42 | 42 | -0.07 (-0.46 to 0.32) |  | 
Linnane-O'Sullivan et al. | 8 | 8 | -0.77 (-2.42 to 1.17) |  | 
Mackay et al. | 39 | 39 | 0.05 (-0.15 to 0.25) |  | 
Marianiello et al. | 23 | 23 | 0.13 (-0.18 to 0.44) |  | 
Pittaway et al. | 47 | 47 | -0.18 (-0.28 to -0.08) |  | 
Pittaway et al. | 27 | 27 | -0.20 (-0.36 to -0.04) |  | 
Shams et al. | 30 | 30 | -0.12 (-0.02 to 0.06) |  | 
Winham et al. | 16 | 16 | 0.13 (-0.31 to 0.57) |  | 
Winham et al. | 23 | 23 | -0.17 (-0.34 to 0.02) |  | 
Zheng et al. | 36 | 36 | -0.21 (-0.41 to -0.01) |  | 
Zheng et al. | 28 | 28 | -0.26 (-0.46 to -0.06) |  | 
Overall: | 604 | 605 | -0.77 (-2.32 to -0.09) |  | 

**Overall:**

↓ LDL by 6.6 mg/dL

**Overall:**

↓ LDL by 10.2 mg/dL

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Pulses - refers to the dried seed/bean

Ha et al. *CMAJ* 2014;186:E252-E262

Cholesterol-lowering effect of soy protein is well established

- Soy's ability to lower plasma cholesterol has been widely studied and well established
- Multiple meta-analyses have been published confirming the cholesterol lowering effects in humans
Soy protein consumption can directly ↓ LDL-C.

Soy protein in place of foods high in SFA & cholesterol can also ↓ LDL-C.

Soy Protein *Intrinsically* Reduces serum LDL-C by 4.3%

Soy Protein *Extrinsically* Reduces serum LDL-C by 3.6 – 6.0%

Meta-analysis of 22 RCTs

Despite the availability of all this evidence, the mechanism of action remains unclear.

Jenkins et al. J Nutr 2010; 140 (12): 2302-2311
Current approved health claims: Cholesterol and CHD risk reduction

<table>
<thead>
<tr>
<th></th>
<th>↓ 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soy</td>
<td></td>
</tr>
<tr>
<td>Nuts (peanuts, 9 tree nuts)</td>
<td>↓ 5%</td>
</tr>
<tr>
<td>Viscous Fibers (oat, barley, psyllium)</td>
<td>↓ 5%</td>
</tr>
<tr>
<td>Phytosterols (plant sterols and stanols)</td>
<td>↓ 5%</td>
</tr>
</tbody>
</table>

Are effects additive?

1% ↓ LDL-C, 1-2% ↓ risk
Comprehensive dietary approach

**Portfolio Diet**
An evidence-based eating plan for lower cholesterol

**David Jenkins**, OC, MD, FRSC, FRCP, FRCPC, PhD, DSc
Professor, Departments of Nutritional Sciences and Medicine, Faculty of Medicine, University of Toronto

Dietary intervention includes

- Almonds
- Low saturated fat
- Soluble fiber
- Soy protein
- Phytosterols
- Fruits/vegetables

Lowers LDL-cholesterol by as much as 30%
Results from study of the Portfolio Diet

From efficacy to effectiveness
Can the portfolio approach be adapted to different habits / dietary traditions?
Dietary intervention

Reduced energy, as recommended by NIH (15 days)

Low Saturated Fat Diet (LSFD)

LSFD and functional foods (60 days)

Department of Physiology of Nutrition of the Instituto Nacional de Ciencias Medicas y Nutricion, Salvador Zubiran, Mexico City

Combination of functional foods consisted of
- 14 g of dehydrated nopal
- 4 g of chia seeds
- 14 g of oats
- 25 g of soy protein
- 4 g of inulin

Functional foods were selected on the basis of their antihyperglycemic, antihyperinsulinemic, hypocholesterolemic, anti-inflammatory, and antioxidant effects caused by the presence of omega-3 fatty acids, b-glycans, vegetable protein of good quality, soluble and insoluble fiber, polyphenols, and a low glycemic index.

Guevara-Cruz, et al. J Am Heart Assoc. 2019
Phase 1 Cross Sectional Study
Prevalence

52% of overweight / obese participants were diagnosed with MetS (542/1032).

There was a significant trend toward an increased prevalence of MetS as BMI increased.

Percentage of participants with and without MetS according to the BMI category: overweight (OW), class I obesity (OCI), class II obesity (OCII), and class III obesity (OCIII).

Guevara-Cruz, et al. J Am Heart Assoc. 2019
Phase 1 Cross Sectional Study
Risk Factors in individuals with overweight / obesity

- Blood pressure was higher in subjects with obesity and MetS.
- Serum triglyceride concentration was higher in subjects with MetS.
- Concentration of serum glucose, insulin, and Homeostatic Model Assessment for Insulin Resistance increased as the BMI increased.
Dietary intervention

Reduced energy, as recommended by NIH (15 days)

Low Saturated Fat Diet (LSFD) (60 days)

LSFD and functional foods

Assessed for eligibility (n = 190)

Excluded (n = 19)
- Not meeting inclusion criteria (n = 10)
- Declined to participate (n = 9)

Selection (n = 171)

Healthy (n = 58)

MetS (n = 73)

MetS + OCII (n = 40)

Randomized (n = 49)

Randomized (n = 61)

Randomized (n = 32)

DI + P (n = 24)

DI + FF (n = 25)

DI + P (n = 31)

DI + FF (n = 30)

DI + P (n = 16)

DI + FF (n = 16)

Loss to follow up (n = 9)

Loss to follow up (n = 8)

Days 15

DI + P (n = 20)

DI + FF (n = 22)

DI + P (n = 29)

DI + FF (n = 29)

DI + P (n = 14)

DI + FF (n = 14)

Loss to follow up (n = 3)

Loss to follow up (n = 1)

Loss to follow up (n = 1)

Loss to follow up (n = 1)

Days 45

DI + P (n = 16)

DI + FF (n = 21)

DI + P (n = 29)

DI + FF (n = 24)

DI + P (n = 13)

DI + FF (n = 14)

Loss to follow up (n = 1)

Loss to follow up (n = 5)

Loss to follow up (n = 1)

Loss to follow up (n = 1)

Days 75

Without fecal sample (n = 6)

Without fecal sample (n = 10)

Without fecal sample (n = 12)

Without fecal sample (n = 8)

Without fecal sample (n = 4)

Without fecal sample (n = 3)

Placebo (n = 10)

DI + FF (n = 11)

Placebo (n = 17)

DI + FF (n = 18)

Placebo (n = 9)

DI + FF (n = 11)
Energy restriction (500 kcal) confers benefit

- Within the first 15 days,
  - Serum triglycerides significantly decreased by 24.1%

- After 2 months of lifestyle intervention
  - waist circumference, BMI, and blood pressure significantly decreased

- Benefits continued with lifestyle intervention of functional foods and energy reduction (500 kcal) for 75 days
  - % body fat
  - OGTT response

Guevara-Cruz, et al. J Am Heart Assoc. 2019
Changes in the intestinal microbiota

- Metabolic abnormalities in subjects with MetS and OCIII+MetS were accompanied by lower a diversity in gut microbiota.

- The lifestyle intervention significantly increased the diversity and species richness compared with the placebo groups.

Guevara-Cruz, et al. J Am Heart Assoc. 2019
Soy Foods Alter the Gut Microbiome

Emerging evidence suggest that soy-based diets can increase the population of the “good” bacteria, such as lactobacilli and bifidobacteria while decreasing the number of “bad” bacteria, such as enterobacteria in the gut microbiota.
Research Links Gut Microbiome and Liver Health

A healthy gut microbiome is characterized by greater microbial diversity. NAFLD progression is characterized by increasing fat accumulation in the liver. The mechanism for fatty liver reduction may be tied to gut microbiota impact.


* Non-alcoholic steatohepatitis (NASH)
Evidence Supports Soy Protein Addresses Hepatic Steatosis

<table>
<thead>
<tr>
<th></th>
<th>Milk Protein Isolate</th>
<th>Milk/Soy Combination</th>
<th>Soy Protein Isolate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver Staining</td>
<td><img src="image" alt="Liver Staining" /></td>
<td><img src="image" alt="Liver Staining" /></td>
<td><img src="image" alt="Liver Staining" /></td>
</tr>
<tr>
<td>Hepatic Steatosis</td>
<td>Higher</td>
<td>Lower</td>
<td>Lower</td>
</tr>
<tr>
<td>Hepatic Lipid Composition</td>
<td>No Change</td>
<td>No Change</td>
<td>Significantly improves PUFA, n3, n6, n7 relative proportions</td>
</tr>
<tr>
<td>Fatty Acid Synthase and Acetyl CoA carboxylase</td>
<td>No Change</td>
<td>No Change</td>
<td>Significantly suppresses hepatic de novo lipogenesis</td>
</tr>
<tr>
<td>Serum Cholesterol</td>
<td>No Change</td>
<td>No Change</td>
<td>Significantly lowers serum cholesterol</td>
</tr>
<tr>
<td>Microbiota</td>
<td>Lower</td>
<td>Higher</td>
<td>α and β-diversity/species richness</td>
</tr>
</tbody>
</table>

Soy protein-based diet decreased hepatic steatosis and de novo lipogenesis, supported higher microbial diversity and species richness which led to upregulation of bile acid signaling pathways and cholesterol homeostasis, compared to milk protein containing diet in a rodent model of obesity.

Adapted from Panasevich et al, Rector. J Nutr Biochem 2017
Medical Complications of Obesity

- Pulmonary disease
  - abnormal function
  - obstructive sleep apnea
  - hypoventilation syndrome

- Nonalcoholic fatty liver disease
  - steatosis
  - steatohepatitis
  - cirrhosis

- Gall bladder disease

- Cancer
  - breast, uterus, cervix, prostate, kidney
  - colon, esophagus, pancreas, liver

- Stroke

- Idiopathic intracranial hypertension

- Coronary heart disease

- Type 2 Diabetes

- Dyslipidemia

- Hypertension

- Gynecologic abnormalities
  - abnormal menses
  - infertility
  - polycystic ovarian syndrome

- Osteoarthritis

- Skin

- Phlebitis
  - venous stasis

- Gout

- Pancreatitis

- Idiopathic intracranial hypertension
## Protein supports improved body composition

### Randomized clinical studies comparing the efficacy of soy vs. animal-based proteins in promoting fat loss as part of a weight loss or weight management diet

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Design, Length</th>
<th>Protein Source</th>
<th>Δ Body Weight</th>
<th>Δ % Body Fat</th>
<th>Δ WC</th>
<th>Additional benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yamashita et al., 1998</td>
<td>WL, Parallel, 16 wks</td>
<td>Soy, Meat</td>
<td>-7.6 kg, -7.8 kg</td>
<td>n/a</td>
<td>-8.6 cm, -8.6 cm</td>
<td>Both protein sources support weight loss equally</td>
</tr>
<tr>
<td>Sites et al., 2007</td>
<td>WM, Parallel, 12 wks</td>
<td>Soy, Casein</td>
<td>0.8 kg, 1.4 kg</td>
<td>+ 1.4%, + 3.4%</td>
<td>-11.9 cm*, + 38.6 cm*</td>
<td>Soy group ↓ abdominal fat</td>
</tr>
<tr>
<td>Lukaszuk et al., 2007</td>
<td>WL, Parallel, 8 wks</td>
<td>Soy, Dairy</td>
<td>-4.3 kg, -3.8 kg</td>
<td>-1.3%, -1.8%</td>
<td>-11.3 cm, -8.7 cm</td>
<td>Both protein sources support weight loss equally</td>
</tr>
<tr>
<td>Anderson et al., 2007</td>
<td>WL, Parallel, 16 wks</td>
<td>Soy, Casein</td>
<td>-14.0 kg, -12.8 kg</td>
<td>-2.9%, -2.7%</td>
<td>-30.0 cm, -33.8 cm</td>
<td>Soy group ↓ plasma glucose</td>
</tr>
<tr>
<td>Liao et al., 2007</td>
<td>WL, Parallel, 8 wks</td>
<td>Soy, Meat/Dairy</td>
<td>-4.0 kg, -3.9 kg</td>
<td>-2.2%, -1.4%</td>
<td>-2.5 cm, -2.9 cm</td>
<td>Soy group ↓ plasma cholesterol</td>
</tr>
<tr>
<td>Christie et al., 2010</td>
<td>WM, Parallel, 12 wks</td>
<td>Soy, Casein</td>
<td>-0.3 kg, + 0.3 kg</td>
<td>+ 0.2%, + 0.5%</td>
<td>-58.8 cm*, + 56.5 cm*</td>
<td>Soy group ↓ abdominal fat, ↓ IL-6 levels</td>
</tr>
<tr>
<td>Neacsu et al., 2014</td>
<td>WL, Crossover, 2 wks</td>
<td>Soy, Meat/Dairy</td>
<td>-2.4 kg, -2.3 kg</td>
<td>-1.1%, -1.0%</td>
<td>n/a</td>
<td>Soy diet ↓ plasma cholesterol</td>
</tr>
<tr>
<td>Van Nielen et al., 2014</td>
<td>WL, Crossover, 4 wks</td>
<td>Soy, Meat/Dairy</td>
<td>-0.5 kg, -1.1 kg</td>
<td>-1.0%, -1.0%</td>
<td>n/a</td>
<td>Soy diet ↓ plasma cholesterol, ↑ insulin sensitivity</td>
</tr>
</tbody>
</table>

**Abbreviations:** WC, waist circumference; WL, weight loss; WM, weight management
* = Soy group significantly different from non-soy protein group (p<0.05)
† = Change in abdominal fat as measured by CT scans
Soy Protein Supports Improved Body Composition

Effects of consuming a high protein diet with or without soy protein during weight loss and maintenance; a non-inferiority, randomized clinical efficacy trial

- 3-phase weight loss trial (4 mo) followed by weight maintenance phase (8 mo)
- Adherence to a higher protein energy-restricted diet (State of Slim) leads to significant loss of body weight, whether protein from varied sources or soy-based products.
- No statistical difference in weight loss between intervention groups
- Both groups lost average 3-4% of body fat during higher protein energy restricted weight loss phase
- Some weight regain occurred during the 8 month follow-up weight maintenance period

No difference in weight loss at month 4 and month 12 between Soy and Non-Soy.

**TOTAL BODY FAT MASS (KG)**

- Higher Protein, Soy
- Higher protein, Non-Soy

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**WEIGHT CHANGE**

- Baseline Month 4 Month 12 Month 4 Month 12
- Soy Non-Soy

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*Speaker, et al. Effects of consuming a high protein diet with or without soy protein during weight loss and maintenance; a non-inferiority, randomized clinical efficacy trial, Obesity Science & Practice, 2018*
High Quality plant protein, such as soy, supports weight management and offers longer term cardiometabolic benefits.
There has been a shift in eating habits that appears to be permanent

**A Wave of Change Towards Plant-Based Diets**

**Health is the Primary Motivation**
The core motivations are health for today, health for tomorrow, and health for the world in which we live.

**Barriers can be Overcome**
The barriers to increased plant consumption appear grounded in perception as much as reality: taste, price, variety, convenience and nutritional content.

**Shift is Permanent**
Over 60% have made changes within the last two years, and an almost equally high number (57%) see this as permanent, versus only 14% who are experimenting.

Is this plant vs animal?
It’s not plant vs animal...most people are reducing animal to make room for plant, but not eliminating it

**Plant = Health**
Providing *physical health benefits* like heart health, immunity and bone health are primary reasons people view plant-based foods and beverages important.

But daily *lifestyle benefits* from a plant-based diet (energy, healthy digestion, avoiding toxins) are equally, if not more important.

**Adding, not Replacing**
Most people are reducing animal-based products to make room for more plant, but for most, *eliminating animal products altogether is not the goal.*
Over half of US Consumers are increasing plant and about 20% more are reducing/avoiding animal

- **18%** exclusive animal reducer/avoider
- **11%** exclusive plant increaser
- **41%** both reducing animal/increasing plant
- **29%** neither reducing animal/increasing plant*

*Those who are neither reducing animal consumption nor increasing plant consumption were screened out of the study and are not included in the remainder of the report analysis.
Globally, about 2 of 3 consumers are increasing plant and 1 of 6 are reducing/avoiding animal

16% Exclusive Animal Reducer/Avoider
11% Exclusive Plant Increaser
54% Both Reducing Animal/Increasing Plant
20% Neither Reducing Animal/Increasing Plant*

*Those who are neither reducing animal consumption nor increasing plant consumption were screened out of the study and are not included in the remainder of the report analysis.
Health-supporting/protective components of plant-based foods

- **Lipid composition (MUFA, PUFA)**
  - Lipid & lipoprotein profile

- **Protein → Amino Acids**
  - Protein synthesis
  - Blood pressure
  - Immune health

- **Fiber & Prebiotics**
  - Lipid lowering
  - Glucose control
  - Satiety
  - Gut health

- **Bioactive constituents**
  - **Vitamins & Minerals**
    - Oxidative stress, endothelial function
  - **Plant sterols**
    - Lipid lowering, endothelial function
  - **Polyphenols**
    - Endothelial function, blood pressure, inflammation

No single food or compound
No single treatment

• No single drug therapy for MetS and the associated comorbidities
• Growing interest in the use of naturally occurring compounds in lowering the risk and progression of MetS.
• Strategies should be cost-effective, culturally sensitive, and adapted to local practices.
Plant Protein, such as Soy, Addresses Risk Factors for MetS and CHD

- **Soy protein improves the diversity of the gut microbiota.**
- **Soy protein can improve blood lipid levels and insulin sensitivity.**
- **Soy protein can help with weight management and reducing abdominal adiposity.**
- **Soy protein supports liver health, improving metabolism of fat in the liver.**
- **Soy consumption can slow the deterioration of glomerular filtration rates and significantly improve proteinuria in chronic kidney disease.**
- **Nutritional interventions that include soy protein are effective to overcome anabolic resistance and support muscle in the aging.**
Summary

- There is evidence to support inclusion of plant-based sources in diet
  - to support health
  - address risk factors associated with conditions that affect many people
- Diets can be adapted to local traditions, but still must be mindful of including sources demonstrated to support health.
- Inclusion of a variety of plant sources that have been studied for efficacy may yield additive benefits.
- Due to differences in composition, different dietary plant protein sources may have differing effects on health.