

Manuscript Title: The Anabolic Response to a Ground Beef Patty and Soy-Based Meat Alternative: A Randomized Controlled Trial

Author List: David Church, Katie Hirsch, Shiloah Kviatkovsky, Joseph Matthews, Arny Ferrando, Gohar Azhar, Robert R Wolfe

Journal and Link: AJCN ([https://ajcn.nutrition.org/article/S0002-9165\(24\)00727-5/fulltext](https://ajcn.nutrition.org/article/S0002-9165(24)00727-5/fulltext))

Study Headline: Ounce for ounce, beef outperforms a soy-based meat alternative patty (Impossible Burger) in stimulating muscle protein synthesis. While soy and beef are both high-quality proteins, it takes twice the amount of the soy-based meat alternative with 66% more calories to elicit the same impact on muscle health.

Background: Muscle protein synthesis is the natural metabolic process in which older, less functional muscle protein fibers are replaced with newer, more functional fibers to support the maintenance or production of muscle mass. Muscle protein synthesis and breakdown rates determine whether the muscle is in an anabolic (building) or catabolic (breakdown) phase, which impacts the overall balance. A positive balance supports maintenance and the building of new muscle protein while a negative balance can result in muscle loss or atrophy. Measurements of muscle protein synthesis is an indicator of muscle health and research continues to support the role of healthy muscle tissue in the prevention of numerous diseases.

All animal protein foods, such as meat, poultry, dairy, and eggs and some plant proteins, such as soy, are complete proteins, that contain all nine essential amino acids (EAAs). Consumption of adequate amounts of EAAs is necessary to stimulate muscle protein synthesis. Previous research has shown that soy protein does not stimulate muscle protein synthesis to the same extent as animal proteins, including beef.^{1,2}

Muscle health declines with age, which is associated with increased chronic disease risk and decreased functional health. Research has demonstrated dietary protein and strength training can help maintain and rebuild muscle at any age, especially beneficial in older adults. As the market for plant-based meat alternatives grows, it is important to understand how the consumption of these ultra-processed, manufactured food products differs in their impact on muscle protein turnover and overall muscle health compared to animal-source protein foods, particularly as they are marketed as equivalent replacements for meat.

¹ Park S, et al. Metabolic Evaluation of the Dietary Guidelines' Ounce Equivalents of Protein Food Sources in Young Adults: A Randomized Controlled Trial. *J Nutr* 2021;151(5):1190-6. doi: 10.1093/jn/nxaa401.

² Pinckaers PJ, et al. Higher Muscle Protein Synthesis Rates Following Ingestion of an Omnivorous Meal Compared with an Isocaloric and Isonitrogenous Vegan Meal in Healthy, Older Adults. *J Nutr* 2024;154(7):2120-32. doi: 10.1016/j.tjn.2023.11.004.

Objective: The objective of this study was to compare muscle protein synthesis rate and whole-body protein kinetics (synthesis, breakdown, and net protein balance) following consumption of: a 4-ounce beef patty (80% lean/20% fat) as compared to either 4- or 8-ounces of a soy-based meat alternative (SBMA) product (Impossible Burger).

Study Design: In a randomized controlled study, 24 healthy adults, ages 18-40, were assigned to one of three groups, with eight participants in each group:

- 1) 4 oz Beef: one 4-ounce beef patty composed of 80% lean, 20% fat ground beef
- 2) 4 oz SBMA: one 4-ounce soy protein patty (1 Impossible™ Burger patty)
- 3) 8 oz SBMA: two 4-ounce soy protein patties (2 Impossible™ Burger patties)

The beef burger patties were formed by hand using 80% lean, 20% fat ground beef. The SBMA patties (Impossible™ Burger patties) were purchased pre-formed. The Impossible™ Burger was selected as it is composed primarily of soy protein, a high-quality plant protein, and specifically manufactured and marketed to mimic a beef burger. All patties were pre-cooked and frozen in marked packages, and the appropriate burger was thawed and heated in a microwave prior to consumption by each study participant.

A stable isotope tracer method was used to determine muscle protein synthesis. Stable isotope tracing allows a marker or “tracking tag” to be followed throughout the body, allowing researchers to analyze how certain nutrients are absorbed and utilized by the body.

Following an overnight fast and a two-day, lead-in diet, participants reported to the research clinic to undergo an isotope tracer infusion and metabolic protocol. Blood samples were collected prior to the initial infusion of tracer amino acids and five times thereafter, then subjects consumed their respective patty or patties before completing the metabolic protocol with an additional nine blood samples. Blood samples were analyzed to determine tracer enrichment and the blood plasma response to dietary EAAs. Additionally, muscle biopsies were obtained at three timepoints throughout the study.

Intervention Details:

Intervention	Ingredients	Calories* (kcal)	Protein* (g)	EAAs* (g)	Leucine* (g)	Fat* (g)	Sat Fat* (g)
One, 4-oz beef patty	80% lean / 20% fat ground beef	279	27.3	10.2	1.96	18	8

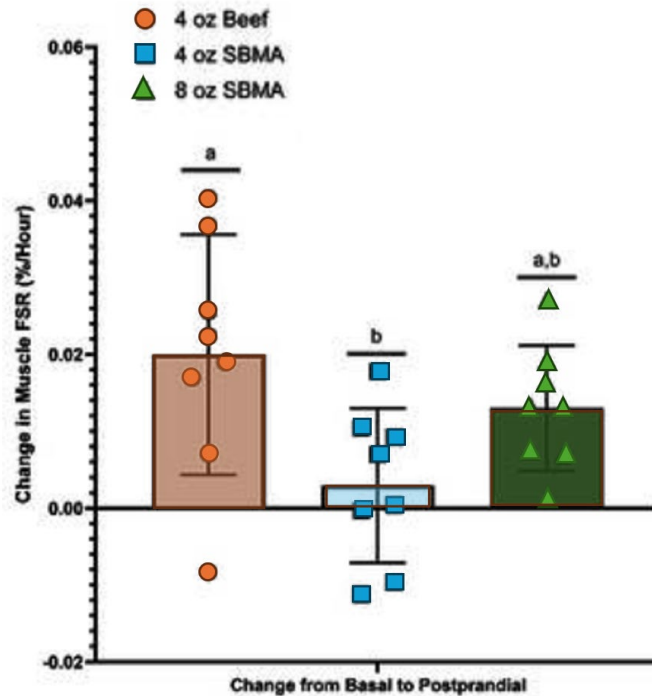
<p>One, 4-oz Impossible™ Burger patty</p>	<p>Water, soy protein concentrate, sunflower oil, coconut oil, natural flavors, 2% or less of: methylcellulose, cultured dextrose, food starch modified, yeast extract, soy leghemoglobin, salt, mixed tocopherols (antioxidant), l-tryptophan, soy protein isolate, vitamins and minerals [zinc gluconate, niacin, thiamine hydrochloride (vitamin B1), pyridoxine hydrochloride (vitamin B6), riboflavin (vitamin B2), vitamin B12].</p>	<p>231</p>	<p>20.5</p>	<p>7.5</p>	<p>1.53</p>	<p>13</p>	<p>6</p>
<p>Two, 4-oz Impossible™ Burger patties</p>	<p>Same as above.</p>	<p>462</p>	<p>40.9</p>	<p>15</p>	<p>3.06</p>	<p>26</p>	<p>12</p>

*The manuscript notes that the nutrient values were obtained from Fanelli NS, et al. Digestible indispensable amino acid score (DIAAS) is greater in animal-based burgers than in plant-based burgers if determined in pigs. Eur J Nutr 2022;61(1):461-75. doi: 10.1007/s00394-021-02658-1.

Key Findings:

- Consumption of a single 4-ounce, 100% beef patty stimulated muscle protein synthesis significantly more than consumption of a 4-ounce, soy-based protein patty, which failed to stimulate muscle protein synthesis at all.
- Consumption of two, 4-ounce soy-based patties (8 ounces total) which provided 66% additional calories, elicited a similar muscle protein synthesis response as a single, 4-ounce beef patty.
- Despite the double serving of SBMA patties (8 ounces) having 13.6 grams more protein and about 5 grams more essential amino acids compared to the single 100% beef burger patty, the protein synthesis rates were similar, suggesting that the beef protein was more efficient to stimulate protein synthesis.
- Amino acids, including essential amino acids, were released at a faster rate following consumption of the 100% beef burger patty compared to the SBMA patties, making amino acids more available to stimulate muscle protein synthesis.

Muscle Protein Synthesis Following the Consumption of Beef versus Equal and Double Amounts of SMBA



Study Implications:

- Although soy is a complete protein, a single, 4-ounce SBMA patty does not stimulate muscle protein synthesis. Failing to elicit a response, the single 4 ounces SBMA patty may be considered “empty calories” in the context of muscle protein synthesis and would need double the serving of SBMA (twice the calories, fat, sodium, etc.) to attain similar synthesis rates as one 4 ounce beef burger patty.
- An individual needs to consume approximately 66% additional calories (462 versus 279 calories) from SBMA (2 Impossible™ Burger patties) to have a similar impact on muscle metabolism as 100% real ground beef. Additionally, the 2 Impossible Burger patties provide 150% more protein and EAAs than the ground beef patty, which demonstrates the higher quality protein in beef than soy.
- Reliance on low-quality proteins to meet EAA recommendations comes at a caloric cost. To achieve the same positive effect on muscle protein synthesis and, ultimately physical function, one would have to consume more of the ultra-processed plant-based product, as compared to a 100% beef burger.

Citation: Church DD, Hirsch KR, Kviatkovsky SA, Matthews JJ, Ferrando AA, Azhar G, Wolfe RR. The anabolic response to a ground beef patty and soy-based meat alternative: a randomized controlled trial. Am J Clin Nutr 2024; 120(5):1085-92.