

References

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MetabolicBiome™ Fuel

Comprehensive Microbiome Fortification

Overview

MetabolicBiome™ Fuel provides a unique macronutrient blend of protein from collagen peptides, fiber from diverse non-grain sources, healthy fats, and a rich blend of plant-based phytochemicals and bioactive nutrients, all designed to support gastrointestinal and metabolic health by promoting a healthy microbiome. The microbiome has been shown to be a core regulator of the body's metabolism, which as we have come to understand, does not simply encompass weight management, but rather the totality and efficiency of how all the systems of the body work together.

An unhealthy microbiome can exhibit itself as dysbiosis linked to disruption of the gut barrier, contributing to endotoxemia-induced inflammation, a key driver of insulin resistance. Dysbiosis also leads to a perturbation of the many microbial metabolites, such as short-chain fatty acids (SCFAs) and branched-chain amino acids (BCAAs) adversely influencing energy balance.¹ SCFAs alone, for example, are considered to be the primary links between diet, systemic health, and the microbiota, and have been shown to help promote immune tolerance and immune antimicrobial effectiveness, and regulate energy metabolism and activity of the gut-brain axis.^{2,3} A growing recognition of the importance of the microbiome to not only metabolism but to every body system on a daily basis, including the cardiovascular and immune systems, highlights the need to provide key micro- and macronutrients for optimal microbiome health.

Key Clinical Benefits of Healthy Microbiome⁴

- Immune system tolerance and immune antimicrobial efficacy
- Maintenance of intestinal barrier integrity
- Inhibition of pathogenic organisms
- Healthy inflammation modulation
- Metabolic support and enhanced insulin sensitivity
- Metabolism of dietary fiber and macronutrients
- Support for bowel motility and detoxification processes
- Synthesis of essential nutrients including B vitamins, vitamin K, conjugated linoleic acid, SCFAs, neurotransmitters and antioxidants
- Amplification of bioactive phytonutrient antioxidants



MetabolicBiome™ Fuel Hydrolyzed Collagen Protein
available in chocolate (#6441)
and vanilla (#6442)

MetabolicBiome™ Fuel Pea Protein
available in vanilla
(#6443)

Collagen Peptides

MetabolicBiome™ Fuel supplies 20g collagen peptides per serving, providing a clinical dose of hydrolyzed amino acids utilized not only for gastrointestinal immune function and protein synthesis, but also as dietary protein essential to the metabolic activity of the microbiome. Collagen is the most abundant protein in the human body, comprising up to 1/3 of all body proteins, with collagen peptides shown to have anti-inflammatory activity associated with a range of benefits, from reductions in joint pain and stimulation of cartilage production to improvements in gastrointestinal permeability.⁵⁻⁷

Cell-based models have shown that collagen peptides improve intestinal barrier integrity in part by inhibiting inflammatory mediators, such as NF-κB and TNF-α, and preventing the breakdown of several tight junction proteins.⁸ Animal models have also shown many metabolic benefits of collagen peptide supplementation, in part, mediated by modulation of the microbiome composition (including a decrease in the *Firmicutes/Bacteroidetes* ratio), as well as a shift in metabolic intermediates, such as an increase in the citric acid cycle intermediate succinate.⁹



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In a small 8-week open-label trial, supplementation with 20g of collagen peptides per day improved mild digestive symptoms in otherwise healthy women. This included a reduction in symptoms of bloating as well as an improvement in bowel frequency, with an overall improvement observed in 93% of women.¹⁰ In a randomized and placebo-controlled clinical trial, 10 to 20g of collagen peptides per day was shown to improve physical function compared to placebo, including improved activities of daily living with both mental and physical components demonstrating benefit.¹¹

Grain-free Plant-based Fiber

MetabolicBiome™ Fuel also provides 9g of grain-free fiber per serving from multiple plant sources, including fiber from non-GM sugar beets, bamboo, apple pectin, fenugreek, organic flaxseed, inulin, and chia seed. Grain-free fibers are an ideal choice of fiber, as they are gluten-free, potent prebiotics, and provide many health-promoting secondary metabolites. Dietary fiber is the cornerstone for a diverse and robust microbiome, and is the component of the diet most associated with the gut microbial community.¹² Higher consumption of dietary fiber has been found to increase the abundance of favorable bacterial species, including *Bifidobacterium* and *Lactobacillus* spp., and to increase the production of anti-inflammatory mediators, especially SCFAs.^{13,14} SCFAs have a broad range of metabolic and gastrointestinal benefits, including improved intestinal barrier integrity and glucose and lipid metabolism.¹² Dietary fiber intake is also associated with a reduction in pro-inflammatory mediators, such as COX-2 and NF-κB, as well as greater immune tolerance and favorable metabolic effects, such as improved insulin sensitivity.¹⁴ A total fiber intake of between 25-29g per day has been associated with a substantial reduction in the risk for multiple chronic conditions, as well as all-cause and cardiovascular mortality.¹⁵

In addition to providing a gluten-free and grain-free source of fiber, **MetabolicBiome™ Fuel** has a unique blend of complementary fibers. Beet fiber, for example, positively modulates the microbiome and is a source of multiple bioactive compounds, including pectic-oligosaccharides, betalains and phenolics, with bifidogenic, antioxidant, and anti-inflammatory effects, as well as stimulation of SCFA production.¹⁶ Similarly, flax and chia seeds are rich in omega-3 fatty acids and several bioactive compounds shown to positively influence metabolic function and reduce inflammation.^{17,18} Flaxseed, for example, is rich in phytosterols as well as α-linolenic acid (ALA) and linoleic acid, associated with a number of cardiometabolic benefits and a reduction in inflammatory mediators (including C-reactive protein and IL-6).^{19,20} Fiber/mucilage from flaxseeds has been shown to decrease the *Firmicutes/Bacteroidetes* ratio, as well as improve satiety and improve markers of metabolism.^{21,22} Apple pectin has been studied for its ability to slow down gastric emptying and increase satiety, and provides polyphenols associated with multiple metabolic benefits.^{23,24} Bamboo shoots contain polysaccharides also shown to modulate the *Firmicutes/Bacteroidetes* ratio, and in a clinical trial were associated with improved metabolic and digestive function.^{25,26} Fenugreek is well-known for its metabolic benefits, and experimental models suggest this may be in part because of its favorable effects on the microbiome; it been shown to modulate multiple metabolic pathways, including those related to bile acid synthesis.^{27,28}

Polyphenols/Antioxidants/Cruciferous Vegetables

MetabolicBiome™ Fuel contains many of the polyphenols, antioxidants, and other secondary metabolites found in a plant-rich diet that are associated with metabolic benefits and a healthy microbiome. This includes blueberries, carrots, and acai berry extract, along with organic sprouts from kale, broccoli, and cauliflower. Blueberries, for example, are rich in phytochemicals, such as quercetin and catechins, as well as a wide range of anthocyanins known for their antioxidant and anti-inflammatory effects.²⁹ Acai berries are also rich in polyphenols and anthocyanins, and both blueberries and acai berries have been shown to modulate the gut microbiota in both animal and human studies, resulting in a greater abundance of *Lactobacillus* and *Bifidobacterium* species, and increasing SCFA production.³⁰⁻³² Polyphenol and anthocyanin-rich fruits, including blueberries and acai, have also been shown to promote the growth of *Akkermansia muciniphila*, a species associated with numerous metabolic benefits related to weight control and glucose homeostasis.^{33,34} Polyphenols also modulate the aryl hydrocarbon receptor, crucial to maintaining intestinal barrier integrity and downregulating inflammatory cytokines, as well as restoring a niche for *Akkermansia muciniphila*.³⁵

Cruciferous vegetable extracts also provide numerous bioactive molecules that support a healthy microbiome, including glucosinolates and their metabolites, more concentrated in cruciferous sprouts than older plants.³⁶ Intake of cruciferous vegetables has been shown to modulate the microbiome, and to provide many of the phytochemicals metabolized by intestinal bacteria into bioactive molecules, including fatty acids and triterpenoids associated with reduced inflammation and improved metabolic function.^{37,38}

Healthy Fats

In addition, **MetabolicBiome™ Fuel** also provides plant-based keto-friendly fats from avocado and coconut oil that enhance palatability and also provide medium chain triglycerides (MCTs) and polyunsaturated and medium-chain fatty acids. These types of unsaturated fatty acids have been associated with favorable metabolic effects, activating multiple anti-inflammatory and protective pathways.³⁹⁻⁴¹ Avocado consumption, for example, has been shown to increase the diversity of the microbiome, increase SCFA levels, and increase the abundance of bacteria capable of fermenting dietary fiber in a randomized and controlled clinical trial, highlighting its potential metabolic benefit when combined with additional fiber intake.⁴²

Highlights

- No artificial sweeteners; sweetened with the natural plant *luo han gao*
- Does not contain undesirable fibers/gums (e.g., NO guar, carrageenan, cellulose)
- Contains 20g protein per serving
- Phytonutrient-rich formulation
- Available in collagen protein (chocolate & vanilla) and organic pea protein (vanilla)
- 3g net carbohydrates
- Keto-friendly



MetabolicBiome™ Fuel Hydrolyzed Collagen Protein
available in chocolate (#6441)



MetabolicBiome™ Fuel Hydrolyzed Collagen Protein
available in vanilla (#6442)



MetabolicBiome™ Fuel Pea Protein
available in vanilla (#6443)

Nutrition Facts	
Servings Per Container: 14	
Serving Size 51 g (approx. 4 level scoops)	
Amount Per Serving	Calories 210
	% Daily Value*
Total Fat 9 g	12%
Saturated Fat 5.5 g	23%
Trans Fat 0g	
Polyunsaturated Fat 1g	
Monounsaturated Fat 3.5 g	
Sodium 130 mg	6%
Total Carbohydrates 11 g	4%
Dietary Fiber 9 g	32%
Total Sugars 0 g	
Includes 0 g Added Sugars	0%
Protein 20 g	40%
Calcium 22 mg	2%
Iron 6 mg	35%

Not a significant source of cholesterol, vitamin D, calcium, iron and potassium.
† 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.

Ingredients: Hydrolyzed beef collagen, avocado oil, coconut oil, acacia gum, non-GM sugar beet fiber, inulin, apple fiber, natural chocolate flavor, natural cocoa, fenugreek fiber, bamboo fiber, pea protein isolate, organic flax seed, apple pectin, chia seed, sunflower lecithin, acai berry extract, blueberry, organic broccoli sprout concentrate, organic kale sprout concentrate, carrot, organic cauliflower sprout concentrate, xanthan gum, silicon dioxide, mixed tocopherols, rosemary extract, sunflower oil, sodium citrate, tricalcium phosphate, natural flavors and *luo han gao* extract.

This product is gluten and dairy free.

KEEP OUT OF REACH OF CHILDREN
Store in a cool, dry area. Sealed with an imprinted safety seal for your protection.

Typical Amino Acid Profile Per Serving:			
Alanine	1,760 mg	Lysine	760 mg
Arginine	1,500 mg	Methionine	180 mg
Aspartic acid	1,200 mg	Phenylalanine	460 mg
Cystine	20 mg	Proline	2,400 mg
Glutamic acid	2,200 mg	Serine	680 mg
Glycine	4,000 mg	Threonine	420 mg
Histidine	220 mg	Tryptophan	72 mg
Hydroxyproline	2,040 mg	Tyrosine	260 mg
Isoleucine†	340 mg	Valine†	600 mg
Leucine†	740 mg		

† Branch chain amino acids

DIRECTIONS: Mix four (4) level scoops of **MetabolicBiome Fuel Hydrolyzed Collagen Protein** with twelve (12) ounces of water, or beverage of your choice. For ease of mixing, use a blender and add the product to room temperature liquid.

Nutrition Facts	
Servings Per Container: 14	
Serving Size 52 g (approx. 4 level scoops)	
Amount Per Serving	Calories 210
	% Daily Value*
Total Fat 9 g	12%
Saturated Fat 4.5 g	23%
Trans Fat 0 g	
Polyunsaturated Fat 1g	
Monounsaturated Fat 3.5 g	
Sodium 130 mg	6%
Total Carbohydrates 12 g	4%
Dietary Fiber 9 g	32%
Total Sugars 0 g	
Includes 0 g Added Sugars	0%
Protein 20 g	40%
Calcium 22 mg	2%
Iron 6 mg	35%

Not a significant source of cholesterol, vitamin D, calcium, iron and potassium.
† 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.

Ingredients: Hydrolyzed beef collagen, natural vanilla flavor, avocado oil, coconut oil, acacia gum, non-GM sugar beet fiber, inulin, apple fiber, fenugreek fiber, bamboo fiber, pea protein isolate, organic flax seed, apple pectin, chia seed, sunflower lecithin, acai berry extract, blueberry, silicon dioxide, mixed tocopherols, rosemary extract, sunflower oil, sodium citrate, tricalcium phosphate, xanthan gum, organic broccoli sprout concentrate, organic kale sprout concentrate, carrot, organic cauliflower sprout concentrate, and *luo han gao* extract.

This product is gluten and dairy free.

KEEP OUT OF REACH OF CHILDREN
Store in a cool, dry area. Sealed with an imprinted safety seal for your protection.

Typical Amino Acid Profile Per Serving:			
Alanine	1,760 mg	Lysine	760 mg
Arginine	1,500 mg	Methionine	180 mg
Aspartic acid	1,200 mg	Phenylalanine	460 mg
Cystine	20 mg	Proline	2,400 mg
Glutamic acid	2,200 mg	Serine	680 mg
Glycine	4,000 mg	Threonine	420 mg
Histidine	220 mg	Tryptophan	72 mg
Hydroxyproline	2,040 mg	Tyrosine	260 mg
Isoleucine†	340 mg	Valine†	600 mg
Leucine†	740 mg		

† Branch chain amino acids

DIRECTIONS: Mix four (4) level scoops of **MetabolicBiome Fuel Hydrolyzed Collagen Protein** with twelve (12) ounces of water, or beverage of your choice. For ease of mixing, use a blender and add the product to room temperature liquid.

Nutrition Facts	
Servings Per Container: 14	
Serving Size 51 g (approx. 4 level scoops)	
Amount Per Serving	Calories 210
	% Daily Value*
Total Fat 9 g	12%
Saturated Fat 4.5 g	23%
Trans Fat 0g	
Polyunsaturated Fat 2 g	
Monounsaturated Fat 2.5 mg	
Cholesterol 0 mg	0%
Sodium 260 mg	11%
Total Carbohydrates 12 g	4%
Dietary Fiber 9 g	32%
Total Sugars 0 g	
Includes 0 g Added Sugars	0%
Protein 20 g	40%
Calcium 22 mg	2%
Iron 6 mg	35%

Not a significant source of cholesterol, vitamin D, calcium, iron and potassium.
† 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.

Ingredients: Organic pea protein concentrate, coconut oil, non-GM sugar beet fiber, avocado oil, inulin, apple fiber, natural vanilla flavor, acacia gum, fenugreek fiber, bamboo fiber, pea protein isolate, apple pectin, organic flax seed, chia seed, acai berry extract, blueberry, organic broccoli sprout concentrate, organic kale sprout concentrate, carrot, organic cauliflower sprout concentrate, sodium citrate, sunflower oil, mixed tocopherols, rosemary extract, sunflower oil and *luo han gao* extract.

This product is gluten and dairy free.

KEEP OUT OF REACH OF CHILDREN
Store in a cool, dry area. Sealed with an imprinted safety seal for your protection.

Typical Amino Acid Profile Per Serving:			
Alanine	817 mg	Lysine	1,451 mg
Arginine	1,625 mg	Methionine	202 mg
Aspartic acid	2,237 mg	Phenylalanine	917 mg
Cystine	202 mg	Proline	843 mg
Glutamic acid	3,164 mg	Serine	922 mg
Glycine	779 mg	Threonine	724 mg
Histidine	473 mg	Tryptophan	188 mg
Isoleucine†	962 mg	Tyrosine	917 mg
Leucine†	1,615 mg	Valine†	1,017 mg

† Branch chain amino acids

DIRECTIONS: Mix four (4) level scoops of **MetabolicBiome Fuel Pea Protein** with twelve (12) ounces of water, or beverage of your choice. For ease of mixing, use a blender and add the product to room temperature liquid.