



A Scientific White Paper

***Research On The Importance Of Whey Protein
For Achieving Optimal Health and Longevity***

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INTRODUCTION

WHAT IS WHEY PROTEIN?

Whey protein, a rich source of the essential amino acids, is a natural high-quality protein from cow's milk. [For those that are lactose sensitive, be certain to consume a whey protein with a high percentage of isolate for optimum absorption and utilization.] Whey protein provides a number of benefits to the immune system, weight management, bone health, and overall general wellness. There are two main proteins in milk: whey protein and casein. The liquid whey protein is separated from the casein protein during the process of making cheese. Because whey protein contains the perfect combination of overall amino acids it is known as the highest quality of protein excelling over meat, vegetable, soy or dairy products. An antioxidant, whey protein supports the immune system increasing glutathione levels. In fact, whey protein contains similar immune boosting ingredients found in a mother's milk. **Introductory Nutrition**, Helen A. Guthrie, Times Mirror/Mosby College Publishing, Boston, MA, 1989, pages 489-490.

BENEFITS OF WHEY PROTEIN

WHEY PROTEIN, TISSUE REPAIR, MUSCLE RECOVERY & HEALING

The significant health benefits of utilizing whey protein in the diet are reported in an article by a professor and Director of the Exercise Science Program at the University of Colorado and author of **Optimal Muscle Recovery**. Dr. Burke outlines the therapeutic benefits of whey protein that deal directly with soft tissue and/or ligamentous tissue repair and healing, immune enhancement, energy production, immune enhancement, fighting infection, and perhaps even fighting cancer. He said he found that whey protein increases the production of collagen, has a direct role in strengthening and growth of the bone, stimulates IGF-1 that enhances protein synthesis, muscle development, pain-killing effects, decrease muscle soreness, and influences Glutathione production. **Better Nutrition**, "12 Different Therapeutic Benefits of Whey Protein" Edmund R. Burke, PhD, November 2003.

"It is critical that protein and nutrient supplementation occur as soon as possible after damage to connective tissue to prevent the body from a generalized lysis (breakdown) stage. Lysis is a reserve mechanism the body uses in other areas away from the injury in order to supply the body with the nutrients it needs to repair the injured area."

When ligaments and connective tissue injury occurs, the body's rebuilding process goes through three phases of healing: (1) Inflammatory Phase where swelling occurs. This phase should be as short as possible so healing can begin. (2) Fibroblastic Phase which is the rebuilding stage that provides strength and a new tissue surface. (3) Remodeling Phase to strengthening tissue occurs and normal function returns. As soon as possible after injury, increase the intake of dietary protein, water, and begin taking a high-quality multivitamin/mineral supplement to aid in the synthesis, repair and regeneration of the various connective tissues involved in the healing process. "A protein deficiency during injury delays all aspects of healing, including a lengthening of the inflammatory phase." **Nutrition Applied to Injury Rehabilitation and Sports Medicine**, L.R. Bucci, CRC Press, 1995;5:S39-S61.

Proline and Lysine are amino acids contained in whey protein which helps to build collagen. [Collagen is the glue that holds the body together.] Collagen is a type of Insoluble Fibrous Glycoprotein formed within the human body, which forms the basis of all fibrous connective tissues within the body. It is a complex molecule that contains 16,000 atoms. Collagen comprises 30% of the body's endogenous proteins which is the most abundant protein in the body. Collagen provides strength, elasticity and permeability to the walls of the blood vessels in the Cardiovascular System. Another biological function of Collagen is in the Immune System shown to inhibit the spread of some forms of cancer and makes up the intima of lymph

vessels. In the Musculoskeletal System, Collagen is an essential component of all connective tissue. It is an essential component of cartilage, joints, muscles, ligaments and tendons. The three principle ingredients of connective tissue are water, Collagen and proteoglycans. “*Collagen Is An Essential Component Of The Intervertebral Discs Of The Spine,*” L.R. Bucci, ***Chiropractic Products***, October 1988:54-56.

WHEY PROTEIN & GLUTATHIONE

Whey Protein contains essential amino acids which are noted to provide overall health benefits. More specifically, whey protein is very beneficial because whey protein drinks increase Glutathione (GSH) concentration in a number of tissues. Whey-based peptide studies have shown that whey protein may reduce hypertension which contributes to cardiovascular diseases. In fact, one of whey protein’s major benefits is to assist in the building of collagen. Therefore, by supplementing whey protein to your diet, it helps to accelerate the healing of fractures as well as provide overall health benefits. Whey protein is also helpful in the prevention and treatment of Osteoporosis. ***American Journal of Clinical Nutrition***, June 2000.

Whey protein increases Glutathione levels. Glutathione (GSH) is a powerful antioxidant. It is a tripeptide protein (made within the body) from three key amino acids; Cysteine, Glutamic Acid, and Glycine. The benefits of Glutathione include detoxifying many toxic chemicals and heavy metals from the body such as lead, mercury, aluminum, arsenic and cadmium, as well as the effects of alcohol and tobacco smoke. In the Immune System, Glutathione inhibits the excessive production of Cytokines that are implicated in Autoimmune Disease. Glutathione combats Free Radicals that cause allergies and aids in Chronic Fatigue. In regards to aging and life extension, old cells contain 20% less Glutathione compared to young cells, indicating it may be beneficial. In the Cardiovascular System, Atherosclerosis patients generally exhibit reduced Glutathione, indicating it may be beneficial. ***Brink; Life Ext.***, 6(2), 2000.

BENEFITS OF AMINO ACIDS IN WHEY PROTEIN

Human beings need protein but more importantly, they need the protein components known as amino acids. They are actually needed for life. When the protein is digested, it is broken down into organic acids which are essential for metabolism, growth, and repair and maintenance of all of the body’s tissues. Only eight of the 22 amino acids are obtained from food because the body cannot make them like they do with the other 14. ***The Pritikin Program for Diet & Exercise,***” Nathan Pritikin, *Bantam Books, New York, 1981, Pages 26-27.*

Whey protein isolate is whey protein derived from milk and is the highest yield of protein available. Whey protein isolate is a source of the essential amino acids (building blocks for healthy muscles, skin, nails and other body tissue) required in the diet daily. ***Staying Healthy With Nutrition***, Elson M. Haas, MD, *Celestial Arts, Berkeley, California, 1992, page 465.*

High-protein low-carbohydrate beverages are being developed and have shown that they might provide health benefits for individuals suffering from chronic illnesses, especially when these beverages contain dairy protein fractions known to be high in essential amino acids. ***J Nutr.*** 2004 April 134(4):996S-1002S.

Amino Acids are the chemical units or commonly known as the building blocks that make up proteins. Because they contain about 16 percent nitrogen, this is what distinguishes them from the other two basic nutrients, sugars and fatty acids. Protein provides the structure for all living things, necessary to every living cell in the body. Proteins are chains of amino acids linked together by peptide bonds with each group of amino acids tailored for a specific need. Proteins are not obtained directly from the diet but are broken down into amino acids which the body then uses to build the specific proteins it needs. It is actually the amino acids rather than the proteins that are the essential nutrients. ***Prescription for Nutritional Healing***, James F. Balch, M.D., Phyllis A. Balch, CNC, 1997, Page 34-35.

Whey protein studies with the accompanying essential amino acids suggests that use of amino acids supplied by whey in the diet caused muscles of the elderly to not only repair, but increase muscle mass even without the use of an exercise program. That's right, increases in muscles and strength instead of slow wasting of muscle mass, all without the added stimulation of exercise. "Essential amino acids are primarily responsible for the amino acid stimulation of muscle protein anabolism in healthy elderly adults," Elena Volpi, Hisamine Kobayashi, Melinda Sheffield-Moore, Bettina Mittendorger, and Robert R. Wolfe, *Am J Clin Nutr* 2003;78:250-8, page 250-258.

There are six key amino acids (Arginine, Glycine, Lysine, Phenylalanine, Proline, and Threonine) which enhances the function and formation of collagen and helps the body (Cystine) to fight cancer formation:

Arginine—Important for muscle metabolism, enhances immune function, retards growth of tumors and cancer, maintains a proper nitrogen balance aiding in the excretion of excess nitrogen, and is helpful for healing and repair of damaged tissue. (*Balch, Page 36*)

Glycine—Retards muscle degeneration by supplying creatine used in the construction of DNA and RNA, essential for the synthesis of nucleic and bile acids, is useful for repairing damaged tissues and promotes healing. (*Balch, Page 39*)

Lysine—An essential amino acid needed to assist in the growth and bone development helping calcium absorption, aids in the production of antibodies, enzymes, hormones, and formation of collagen. Good for take for recovering from surgery and sports injuries. (*Balch, Page 40*)

Phenylalanine—An essential amino acid, converts into another amino acid (tyrosine) which promote alertness, suppresses appetite, elevates mood, decrease pain, aids memory, and used to treat depression, migraines, obesity, arthritis, schizophrenia, and menstrual cramps. (*Balch, Page 41*)

Threonine—An essential amino acids to maintain the protein balance in the body, aids in the formation of collagen and elastin, aids the liver in lipotropic function, helps to prevent fatty building in the liver, and enhances the immune system. (*Balch, Page 41-42*)

Proline—Aids in the production of collagen, helps in the healing of cartilage, strengthens heart muscle, joints and tendons. *Prescription for Nutritional Healing*, James F. Balch, M.D., Phyllis A. Balch, CNC, 1997, Page 34-35.

WHEY PROTEIN & OSTEOPOROSIS

Research shows that whey protein helps prevent and treat Osteoporosis by increasing the number of Osteoblasts at the expense of osteoclast. Osteoporosis is a condition where bones become less dense from osteoclastic versus osteoblastic dominance. Female osteoporosis usually commences about 15 years prior to menopause with bone losses occurring at the rate of 1% per year. The research showed individuals with osteoporosis have an increase in backaches plus show a greater risk of atherosclerosis, fractures, and Cachexia. "Whey protein stimulated the proliferation and differentiation of osteoblastic cells," *Biochem Biophys Res Commun*, 223(2):445-449, 1996; Takada, Y., et al.

Protein intake in the diet plus an additional 20 grams per day of a supplemental dietary protein accelerated the healing of fractures as well as helped to prevent osteoporotic fractures. *American Journal of Clinical Nutrition*, 69(1):147-152, 1999 & *Nutrition Review*, 56:337-340, 1998.

Protein drinks, once *incorrectly* taunted with increasing the risk of Osteoporosis by leaching the calcium from the bones, are now noted to provide health benefits. This study further reported that there was strong evidence that daily protein intake was a means of Osteoporosis prevention. *American Journal of Clinical Nutrition*, 66:147-152, 1992 and *Food Chem News*, Nov. 7, 1997:9.

THE EFFECTS OF WHEY PROTEIN ON NEUROTRANSMITTER FUNCTION

Essential Amino Acids, the building blocks that make up proteins, play a large part in every living cell in the body. Each group of amino acids is tailored for a specific need. It is actually the amino acids rather than the proteins that are the essential nutrients. Amino acids act as neurotransmitters to carry information from one nerve cell to another. The neurotransmitter dysfunction is caused by the lack of amino acids. The dysfunction of the neurotransmitters results in depression and obesity with further results in diabetes, heart diseases, hypertension (high blood pressure), and lack of emotional control. *“Essential amino acids are primarily responsible for the amino acid stimulation of muscle protein anabolism in healthy elderly adults,” Elena Volpi, Hisamine Kobayaski, Melinda Sheffield-Moore, Bettina Mittendorfer, and Robert R. Wolfe, Am J Clin Nutr 2003;78:250-8.*

Amino acids also act as neurotransmitters to carry information from one nerve cell to another. Amino acids enable vitamins and minerals to do their jobs properly, but if there is a deficiency in amino acids, nerve cells can't function. There are approximately 28 amino acids. The liver produces 19 amino acids while the other 9 must be obtained from the diet which is called the essential amino acids. *Prescription for Nutritional Healing, James F. Balch, M.D., Phyllis A. Balch, CNC, 1997, Page 34-35.*

Plainly, the neurotransmitter dysfunction is caused by the lack of amino acids. The dysfunction of the neurotransmitters results in depression and obesity with further results in diabetes, heart diseases, hypertension (high blood pressure), and lack of emotional control. The neurotransmitters are fat soluble and cannot cross the blood/brain barrier. Therefore, the amino acids that made up the neurotransmitters must cross the blood/brain barrier and then the body makes the neurotransmitters out of the amino acids and the appropriate vitamins and minerals necessary. *Neurotransmitter Testing and Amino Acid Therapy, Marty Hinz, MD, NeuroResearch, Morgan Park Clinic, Duluth, Minnesota, 2002, Pages 22-24.*

Nutritional deficiency is a major cause of neurotransmitter dysfunction, as well as drugs such as Zoloft and Prozac. These drugs inhibit the reuptake of serotonin and so cause a loss of serotonin. Neurotoxic effects are permanent. They are caused by heavy metals, chemicals and drugs. The main drug that causes neurotoxicity is amphetamines. Neurotoxic effects are in the post-synaptic neurons. The treatment is the same as deficiency of amino acids, but it takes more of these amino acids forming serotonin to be effective at the post-sympathic neuron. *Neurotransmitter Testing and Amino Acid Therapy, Marty Hinz, MD, NeuroResearch, Morgan Park Clinic, Duluth, Minnesota, 2002, Pages 22-24.*

WHEY PROTEIN & CARDIOVASCULAR DISEASE

Whey-based peptides have demonstrated activity that may reduce hypertension and dyslipidemia contributing to incidence of cardiovascular diseases worldwide. *Cardiovascular Health, 2001, “Bioactive Components of Whey and Cardiovascular Health,” Sharon K. Gerdes, Wes Harper, G. Miller.*

EFFECT OF WHEY PROTEIN ON TUMORS

Whey protein diets result in increase Glutathione (GSH) concentration in a number of tissues, and that some of the beneficial effects of whey protein suggest that dietary milk products may exert an inhibitory effect on the development of several types of tumors. *“Whey proteins in cancer prevention” Cancer Lett., Bounous, G. Batist G, Gold P. 1991, May 1;57(2):91-4.*

WHEY PROTEIN AIDS IN BURNING BODY FAT

A study shows that whey protein is better than whole milk proteins in burning body fat. In other words, whey protein actually helps to build muscle through essential amino acids. Whey protein also helps muscles to recover and grow by bringing up the levels of protein. To aid in dieting and to lose extra fat, whey protein aids in the balancing of blood sugar levels. Because the blood sugar levels stays in balance, there then is greater fat loss plus more energy, helping the body burn fat as well as allowing control of your diet. *American Journal of Clinical Nutrition, June 2000 .*

A study reported in the *American Journal of Clinical Nutrition* found what the body uses for food for a workout and if that substance helps body burn body fat. After testing four groups: fasting, sugar, milk protein, and whey protein groups, the results showed that the fasting group gained no weight. The sugar group burned sugar consumed and no body fat burned. The milk protein group burned protein consumed and body fat. The whey protein group burned protein consumed and body fat. The sugar, milk protein, and whey protein groups gained weight. However, only the group given whey protein gained weight by adding muscle and losing body fat. The other two groups gained weight by increasing body fat. This study showed that whey protein is superior to other proteins for increasing muscle mass and decreasing body fat. *American Journal of Clinical Nutrition*, June 2000.

BENEFITS OF ADDING PROTEIN TO BREAKFAST MEAL

Skipping breakfast has increased, according to recent research. The people studied indicated that they thought by skipping breakfast it would reduce calories. However, of the 3,000 people who participated in this study, those who ate breakfast not only lost weight but kept it off for 6 years, thus concluding that eating breakfast helps weight loss. The researchers found that those who ate breakfast with protein had less hunger mid morning and they did not have cravings that might lead to over consumption of junk food later in the day. Breakfast eaters who consume protein are better able to do physical activity, which may stimulate a low calorie eating lifestyle. Therefore, eating breakfast can lead to successful weight loss maintenance. “*Long-Term Weight Loss and Breakfast in Subjects in the National Weights Control Registry*,” *Muscular Development Magazine*, Holly R. Wyatt, Gary K. Grunwald, Cecilia L. Mosca, Mary L. Klem, Rena R. Wing, and James O. Hill, *Research from University of Colorado Health Sciences Center & University of Pittsburg School of Medicine*, June 2002 (*Obesity Res.* 10; 78-92; 2002).

STEVIA IN WHEY PROTEIN POWDERS

For most people it is important to choose a whey protein power that tastes good. But, be certain to read the labels to see if there are artificial sweeteners that try to improve the taste. It's best to avoid whey protein powers that contain sugar, fructose, Aspartame, Sucralose or any artificial form of sugar. Look for a product that uses natural sweeteners such as Stevia.

Stevia (*Stevia Rebaudinana*), an herb in the Chrysanthemum family, is a small shrub with green leaves that grows wild in Brazil, Paraguay, Japan and China. The sweetness comes from the leaves, in fact, it is 30 times sweeter than sugar, but has none of sugar's unhealthy drawbacks such as toxicity. The leaf contains carbohydrates, fiber, proteins, calcium, potassium, magnesium, iron, phosphorous, zinc, and vitamins (A and C) and has a slight licorice taste. Stevia also makes an excellent sweetener for baking and for cooking. There are scientific health benefits to ingesting Stevia such as helping to regulate blood sugar because it digests slowly (without the blood sugar swing of high and then low), lowers elevated blood pressure while it does not affect normal blood pressure. Stevia can be used in weight loss as it contains no calories and helps people to feel full sooner. Other benefits include digestion function and soothes upset stomachs. *Bonvie, Linda and Bill, and Gates, Donna, "The Stevia Story. A tale of incredible sweetness and intrigue" B.E.d. Publications, Atlanta, GA p 13-17.*

BENEFICIAL SOLUBLE FIBER IN WHEY PROTEIN POWERS FRUCTOOLIGOSACCHARIDES (FOS)

A good whey protein product should contain a high-quality soluble fiber. A good soluble fiber, such as Fructooligosaccharides (FOS), has shown to encourage growth of favorable bacteria which helps to assist the digestion of food, promote regularity, and strengthen the immune system.

A family of carbohydrates called Fructooligosaccharides (FOS), a soluble fiber (not digestible) that has been shown to encourage growth of favorable bacteria which help to strengthen the immune system, assist in the digestion of food and amino acids, as well as help to promote regularity. FOS feed bifidobacterium

and lactobacillus. FOS, a “prebiotic,” is a special food only probiotics eat which encourages the development of the friendly bacteria already in the body. FOS can be found in asparagus, beets, onions, chicory, garlic and Jerusalem artichokes or they can be taken as a supplement or in a formula. *The pH Miracle*, Robert O. Young and Shelley Redford Young, Warner Books, New York, New York, 2002, Page 48.

FOS are short-chain polymers composed of simple carbohydrates. FOS are supportive of the intestinal probiotics, especially the bifidobacteria. It can be taken to prevent digestive ailments such as constipation and diarrhea. FOS's healthful effects is found to be effective on intestinal bacteria after taking antibiotics, a poor diet, or constant stress. FOS also increases enzyme levels. (Internet: www.medicinalfoodnews.com/vol01/issue6/fructo.htm).

ADDITIONAL RESEARCH ON BENEFITS OF WHEY PROTEIN

Functional properties of whey, whey components, and essential amino acids: mechanisms underlying health benefits for active people (review).

Ha E, Zemel MB. Functional Ingredients Research, Inc, Twin Falls, Idaho, USA.

Whey proteins and amino acid supplements have a strong position in the sports nutrition market based on the purported quality of proteins and amino acids they provide. Recent studies employing stable isotope methodology demonstrate the ability of whey proteins or amino acid mixtures of similar composition to promote whole body and muscle protein synthesis. Other developing avenues of research explore health benefits of whey that extend beyond protein and basic nutrition. Many bioactive components derived from whey are under study for their ability to offer specific health benefits. These functions are being investigated predominantly in tissue culture systems and animal models. The capacity of these compounds to modulate adiposity, and to enhance immune function and anti-oxidant activity presents new applications potentially suited to the needs of those individuals with active lifestyles. This paper will review the recent literature that describes functional properties of essential amino acids, whey proteins, whey-derived minerals and other compounds and the mechanisms by which they may confer benefits to active people in the context that exercise is a form of metabolic stress. The response to this stress can be positive, as with the accretion of more muscle and improved functionality or greater strength. However, overall benefits may be compromised if immune function or general health is challenged in response to the stress. From a mechanistic standpoint, whey proteins, their composite amino acids, and/or associated compounds may be able to provide substrate and bioactive components to extend the overall benefits of physical activity. *J Nutr Biochem. 2003 May;14(5):251-8.PMID: 12832028.*

Therapeutic applications of whey protein.

Marshall K.

Whey, a protein complex derived from milk, is being touted as a functional food with a number of health benefits. The biological components of whey, including lactoferrin, beta-lactoglobulin, alpha-lactalbumin, glycomacropeptide, and immunoglobulins, demonstrate a range of immune-enhancing properties. In addition, whey has the ability to act as an antioxidant, antihypertensive, antitumor, hypolipidemic, antiviral, antibacterial, and chelating agent. The primary mechanism by which whey is thought to exert its effects is by intracellular conversion of the amino acid cysteine to glutathione, a potent intracellular antioxidant. A number of clinical trials have successfully been performed using whey in the treatment of cancer, HIV, hepatitis B, cardiovascular disease, osteoporosis, and as an antimicrobial agent. Whey protein has also exhibited benefit in the arena of exercise performance and enhancement. *Altern Med Rev. 2004 Jun;9(2):136-56PMID: 15253675.*

Efficacy of a whey protein concentrate on the inhibition of stomach ulcerative lesions caused by ethanol ingestion.

Rosaneli CF, Bighetti AE, Antonio MA, Carvalho JE, Sgarbieri VC.

Instituto de Tecnologia de Alimentos, Av. Brasil, 2880-CEP 13081-001, Campinas, SP-Brasil.

The purpose of this research was to test the ability of a whey protein concentrate (WPC) to inhibit gastric mucosal ulcerative lesions caused by oral administration to rats of absolute ethanol. Acute administration (single doses) of WPC resulted in 41% inhibition of the ulcerative lesion index (ULI), and 73% inhibition was obtained with repetitive doses. In a 10-days subchronic treatment study, the inhibition was 64%, all relative to a saline treatment (negative control). Alkylation of sulfhydryl compounds by subcutaneous injection of N-ethylmaleimide essentially eliminated the WPC protection. Treating the rats with an intraperitoneal injection of butathionine sulfoximine, which inhibits glutathione synthesis, reduced WPC protection to 35% and 52% for single and double doses, respectively. Taken as a whole, the results indicate that WPC does protect gastric mucosa from ethanol damage and that the protection depends on sulfhydryl compounds present in the WPC, including its capacity to stimulate glutathione synthesis. *J Med Food. 2002 Winter;5(4):221-8PMID: 12639397.*

Whey protein concentrate (WPC) and glutathione modulation in cancer

treatment. *Bounous G. Research & Development Department, Immunotec Research Ltd., 292 Adrien-Patenaude, Vaudreuil-Dorion, Quebec, Canada, J7V 5V5.*

The glutathione (GSH) antioxidant system is foremost among the cellular protective mechanisms. Depletion of this small molecule is a common consequence of increased formation of reactive oxygen species during increased cellular activities. This phenomenon can occur in the lymphocytes during the development of the immune response and in the muscular cells during strenuous exercise. It is not surprising that so much research has been done, and is still being done on this small tripeptide molecule. Whey protein concentrate has been shown to represent an effective and safe cysteine donor for GSH replenishment during GSH depletion in immune deficiency states. Cysteine is the crucial limiting amino acid for intracellular GSH synthesis. Animal experiments showed that the concentrates of whey proteins also exhibit anti-carcinogenesis and anticancer activity. They do this via their effect on increasing GSH concentration in relevant tissues, and may have anti-tumor effect on low volume of tumor via stimulation of immunity through the GSH pathway. It is considered that oxygen radical generation is frequently a critical step in carcinogenesis, hence the effect of GSH on free radicals as well as carcinogen detoxification, could be important in inhibiting carcinogenesis induced by a number of different mechanisms. Case reports are presented which strongly suggest an anti-tumor effect of a whey protein dietary supplement in some urogenital cancers. This non toxic dietary intervention, which is not based on the principles of current cancer chemotherapy, will hopefully attract the attention of laboratory and clinical oncologists.

Anticancer Res. 2000 Nov-Dec;20(6C):4785-92.PMID: 11205219.

SUMMARY

The Standard American Diet (S.A.D.) has given rise to an epidemic of obesity, cardiovascular disease, premature aging and cancer. The research on the importance of adding whey protein to the diet for optimal health is conclusive.

Wellness Watchers is dedicated to the development of “functional foods” that can be included in the dietary fabric of the busy, modern world. People will continue to only eat what they like, therefore; our mission is to create good tasting, instant, healthy super foods that lead to an optimal diet and increased vitality and well-being. For more information, visit: www.greensfirst.com



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