THE EVIDENCE FOR OPTIMSM
JOINT HEALTH

MAINTAINING JOINT MOBILITY

Healthy joints are fortified with cartilage and synovial fluid, providing a buffer between the bones and helping to reduce friction. Healthy joints adapt to physical stress by altering structural components within the cartilage to enable normal extension and flexion. When joint biomechanics are not normal, joints do not adequately adapt to changing conditions and cartilage is not replenished. Swelling, stiffness, and arthritis are common symptoms with localized inflammation destructive to cartilage tissue. While the cause of injury varies, age-related cartilage degradation and previous damage are common factors

THE ROLE OF OPTIMSM®

Methylsulfonylmethane (MSM) is an organic sulfur-containing compound with extensive research supporting its use in the area of joint health. MSM's sulfur content (roughly 34% elemental sulfur) is used by the body to maintain healthy connective tissues.

Bergstrom Nutrition pioneered the use of MSM and continually invests in research for human health applications. Bergstrom Nutrition's trademarked OptiMSM® is the only MSM produced in the U.S. and the purest and only GRAS-designated MSM.

Clinical studies demonstrate MSM alleviates joint pain and stiffness while improving mobility and quality of life in people suffering from joint issues. There are three potential mechanisms to explains this:

1. In arthritic cartilage, the concentration of sulfur is one-third the level of healthy cartilage in similar conditions (Rizzo, 1995). MSM, as a sulfur donor, helps maintain healthy connective tissue as the SAA's are used to synthesize the chondroitin matrix of cartilage (Baker, 1986).
2. There appears to be a correlation between oxidative damage and cartilage degeneration in osteoarthritis (Yudoh, 2005). MSM is known to demonstrate positive effects upon markers of oxidative stress (e.g., homocysteine), thereby potentially reducing the rate of degeneration.
3. Several in-vivo studies demonstrate MSM possesses selective anti-inflammatory activity, particularly the inhibition of the inflammatory cytokines IL-6 and TNF-a both key in producing an inflammatory response to acute injury.

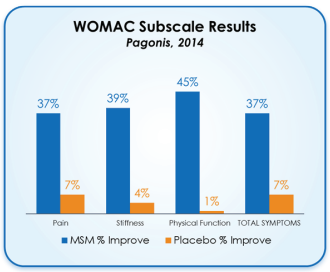
THE SCIENTIFIC EVIDENCE

In a randomized, double-blind, placebo-controlled trial, Kim et al. demonstrated that 3g of OptiMSM consumed twice daily over 12 weeks improved symptoms of pain and physical function as assessed in 50 men and women with osteoarthritic knee pain. OptiMSM also produced improvements in performing activities of daily living when compared to placebo based on SF-36 assessment. The subjects continued to improve beyond the investigation period suggesting the full benefits of OptiMSM are even better over an extended period (>3 months).

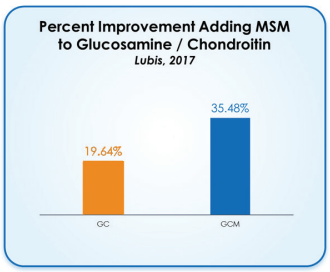
Subsequent research corroborated the findings of Kim et al. and extended the duration of active MSM treatment. In a randomized, double-blind, placebo-controlled trial, 100 subjects consumed 3g of MSM twice daily for 26 weeks (Pagonis, 2014). The control group experienced significant decreases in all subscales of WOMAC pain and physical index as well as improved performance of daily living as measured on the SF-36. The WOMAC subscales continued to decline at 26 weeks, again suggesting the benefits of MSM in OA sufferers continue to increase well beyond the periods studied.

Research on combination supplements (Lubis, 2017), demonstrates a dose of 500 mg of MSM combined with glucosamine and chondroitin provides a significant reduction of pain and improvement in physical function over the same formula without MSM.

There is a clear benefit for consumers with osteoarthritis to consume OptiMSM. As a result, OptiMSM should receive serious consideration in joint health formulations.



Percent improvement in WOMAC Subscales and Total Symptoms of MSM compared to placebo.



Percent improvement in WOMAC Total Symptoms – Glucosamine/Chondroitin (GC) vs GC + 500mg MSM (GCM)

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OptiMSM®

THE EVIDENCE FOR OPTIMSM®
SKIN HEALTH

MAINTAINING A HEALTHY APPEARANCE

Skin is a dynamic organ (rapid cell turnover) and requires a constant supply of nutrients to help maintain a healthy structure and function. If this supply is disrupted, it may lead to sagging, tired-looking skin or mottled pigmentation (dark spots). If supply is compromised for a long period, this can lead to premature aging and a weakening of the extracellular matrix (ECM). The process is accelerated by external factors such as direct sunlight, or pollution (for example).

ENSURING A STRONG EXTRACELLULAR MATRIX

The ECM is a fiber meshwork of collagen and elastin which keeps the skin looking healthy. If the ECM is weakened (a breakdown of collagen-rich connective tissue), then the skin becomes thinner and more susceptible to permanent damage (fine lines and wrinkles).

In contrast, nutrients that can increase skin membrane permeability, prevent collagen/proteoglycan breakdown and reduce inflammation on and under the surface of the skin can strengthen the ECM and improve the appearance of the skin in both the short and long-term.

THE ROLE OF OPTIMSM®

Methylsulfonylmethane (MSM) is an organic sulfur-containing compound with extensive research supporting its use. MSM's sulfur content is used by the body to maintain healthy skin, hair and nails.

Bergstrom Nutrition pioneered the use of MSM and continually invests in research for human health applications. Bergstrom

Nutrition's trademarked OptiMSM® is the only MSM produced in the U.S. and the purest and only GRAS-designated MSM.

MSM, in the form of OptiMSM, has been shown to reduce fine lines and wrinkles, improve skin texture and elasticity, and provide overall support to the structural integrity of the skin. It may also help the skin, hair, and nails to regain and retain a more youthful appearance. There are three primary mechanisms that explain these benefits:

1. MSM is a source of sulfur which supports cross-linking of proteoglycans and collagen, as well as serving as a building block for keratin, the chief structural constituent of hair and nails. By maintaining healthy collagen, cross-linking, or "hardening" of the tissue is inhibited, allowing for healthy skin function.
2. OptiMSM improves antioxidant capacity and helps reduce inflammation (IL-6 and TNF-a), which is a cause of skin damage and degradation of the skin's structural matrixes.
3. MSM increases the barrier function of the ECM, which enables a greater exchange of water and nutrients in the dermis. Pre-clinical results from a gene marker study also suggest MSM can modify the genes (DSG3 and LCE3D) associated with barrier function.

THE SCIENTIFIC EVIDENCE

In a randomized 16-week, DB, PC, study, 23 women (35-59 yrs) consumed 3g of OptiMSM or placebo per day for 16 weeks. Expert grading, instrumental assessments, and self-assessments were measured at weeks 0, 8, & 16.

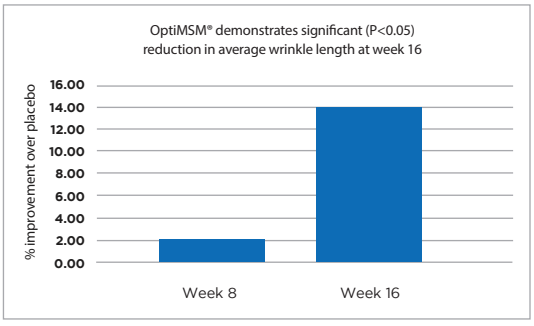
There was a reduction in number, size, and wrinkle severity for all assessments with an overall 34% reduction in wrinkles, and a 66% reduction in deep lines showed improvements deep within the skin.

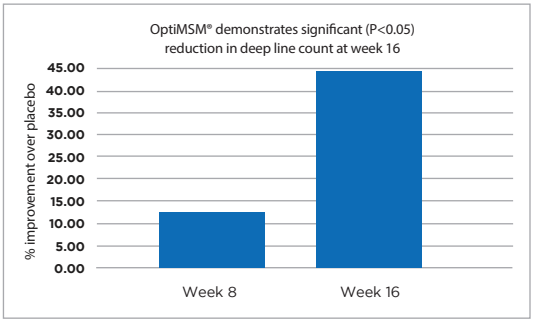
Expert grading showed significant improvements for crow's feet, tone, smoothness, elasticity, and firmness. These findings were affirmed by results from Clarity™ Pro digital analysis, with significant improvements in crow's feet and total wrinkle count, length, severity, and depth. **Vapometer results saw barrier function of 100% of MSM subjects improved. Positive self-assessments affirmed that the results were noticeable to subjects.**

A recently published follow-up study of 63 women (35-59 yrs) subjects consumed either 1g or 3g of OptiMSM per day. Similar measurements displayed significant improvements in wrinkles, firmness, elasticity, radiance, and hydration were observed at both doses and across all three measures, showing **efficacy at 1g/day** and confirming the results of the first study.

The follow-up study also measured hair and nail outcomes. The results showed benefits for shine, volume, and overall health of hair, plus shine, strength, and overall health of nails, giving evidence to MSM's use for overall beauty benefits.

And a separate study showed the benefits of an MSM, l-Carnosine, and HA combination for skin wrinkles, hydration, and elasticity, showing that MSM works in concert with other ingredients.





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OptiMSM®

THE EVIDENCE FOR OPTIMSM
SPORTS AND ACTIVE NUTRITION

The need state of joint health in relation to the management of "injuries" in sports nutrition is significant. Particularly in elite or high-level athletes where injury is one of the primary reasons for missing training and competition. As a result, the majority of sports nutrition brands extend their product range beyond protein and amino acids with relevant dietary supplements. Joint/Injury products are a primary product in this extended platform.

As sports nutrition continues to evolve with increased relevance to active everyday consumers, there is increasing need and interest in joint, injury, and recovery products. The need is less about performance per se, but enabling an individual to keep training and supporting the process of long term behavior change.

THE BALANCE BETWEEN ADAPTATION AND RECOVERY

There is a delicate balance between training, adaptation, and recovery. The overload principle dictates the body needs to be stressed to adapt and improve. However, if the level of stress is greater than what the body can tolerate, significant levels of oxidative stress, inflammation and muscle damage will occur, resulting in increased fatigue and reduced performance.

Nutritional strategies that help facilitate and speed up the recovery process are essential in assisting athletes to maintain adherence to their training programs, while for active exercisers; it is more a case of keeping them fit and healthy and able to continue exercising.

THE ROLE OF OPTIMSM®

Methylsulfonylmethane (MSM) is a sulfur-containing compound with extensive research supporting its use. MSM's sulfur helps the body maintain healthy connective tissue.

Bergstrom Nutrition pioneered the use of MSM and their trademarked OptiMSM® is certified by Informed-Choice and the only U.S. made and GRAS designated MSM.

When consumed daily for a period between 10 to 28 days, MSM has been shown to mitigate oxidative stress from exercise and subsequently exercise recovery and performance. The scientific evidence to support OptiMSM has focused on four areas.

- MSM reduces exercise-induced oxidative stress and increases anti-oxidative capacity

Endurance exercise significantly increases oxidative stress in athletes. Runners participating in a 14k run had increased levels of oxidative markers, serum malondialdehyde (MDA), protein carbonyl (PC), and plasma oxidized glutathione (GSSG). 10 days' of MSM supplementation before the run not only reduced the levels of the oxidative markers, it also increased plasma antioxidative capacity (Nakhostin-Roohi et al., 2011).

- MSM reduces resistance and endurance exercise-induced muscle damage and improves recovery

MSM helps to protect muscles from exercise-induced damage and aids recovery in endurance (Barmaki et al., 2012) and resistance exercise (Kalman et al., 2013). Following a 14k endurance run, creatine kinase (CK), a marker of muscle damage, was significantly elevated. However, 10 days of supplementation with MSM prior to exercise significantly reduced CK (Barmaki et al., 2012). In another endurance-focused study, 3g of OptiMSM for 21 days before a half-marathon attenuated post-exercise muscle discomfort (Withee et al., 2015).

In terms of resistance exercise, the consumption of 3g of OptiMSM per day for 28-days prior to 18 sets of muscle-damaging knee extension exercise favorably improved markers of exercise recovery (Kalman et al., 2012). In a follow-up study, 3g of OptiMSM per day for 14-days before a leg extension exercise to muscle failure resulted in significantly lower muscle discomfort 2 hours post-exercise when compared to a placebo (Kalman et al., 2013).

- MSM improves inflammatory response to exercise

OptiMSM improves the inflammatory response following exercise (Benjamin et al., 2015). A single bout of acute exercise (10 sets of 10 repetitions of eccentric knee extensions) increased systemic levels of inflammatory cytokines (IL-6) immediately after training. However, 28 days of OptiMSM supplementation before the exercise sessions not only reduced the levels of pro-inflammatory markers (IL-6), OptiMSM increased anti-inflammatory markers (IL-10).

- MSM improves performance after damaging exercise

OptiMSM supplementation improves knee joint kinetics during running following eccentric knee extensor damage (Peel et al., 2015). Knee extensor maximal isometric force (MIF) returned to baseline values in the OptiMSM group at 72 hours but remained lower than baseline in the placebo group. This suggests OptiMSM speeds up MIF return to baseline, allowing individuals to return to training faster using OptiMSM.

OPPORTUNITIES IN RECOVERY BEYOND PROTEIN

Sports nutrition is dominated by protein and amino acids and the goal of muscle mass or tone. However, the role of inflammation and oxidative stress is overlooked; particularly in recovery. The management of inflammation and oxidative stress during periods of heavy training or competition is of huge concern to athletes and needs to be better addressed in product solutions.

Interestingly, the relevance extends to active everyday consumers on the basis that aging and additional life stress potentially inhibits the recovery process. Managing the acute response to recovery and regeneration is crucial to ensuring a consumer "feels" better, sooner. It's probably the primary recovery need given the substrate utilization is unlikely to be compromised by exercise, and the diet would include sufficient protein. The ability to add OptiMSM as part of a pre-workout or recovery formula coupled with its well-known joint support benefits represents an innovative and marketable approach to sports nutrition.

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OptiMSM®

THE IMPORTANCE OF SULFUR IN HUMAN NUTRITION

SULFUR - THE FORGOTTEN NUTRIENT

Sulfur is an inorganic element and forms part of several molecules in the body, including amino acids, proteins, enzymes, vitamins, and more.[1] Following calcium and phosphorus, sulfur is the third most abundant mineral in the human body, representing ~0.3% of total body mass.[2]

Dietary sulfur comes from protein where 2 of the 20 amino acids, methionine, and cysteine, contain sulfur (the sulfur-containing amino acids; SAAs). The amount of SAAs in protein varies according to the source, e.g., dairy is 4% SAAs and egg whites 8% SAAs.[3] Additionally, glutathione (a natural intracellular antioxidant) provides a source of dietary sulfur and is found in fruits and vegetables.[4]

Currently, there is no recommended dietary allowance (RDA) for sulfur. There is, however, a recommended daily intake for the sulfur-containing amino acids. The estimated requirement for methionine (combined with cysteine) was determined in 1989 to be 14 mg/day per kg body weight in adults.[3]

THE ROLE OF SULFUR IN THE BODY?

Historically, sulfur has been considered important in soil and plant health, rather than human health. However, its role - direct and indirect - is significant.

Best known is the role of sulfur and its benefits for skin, including appearance (skin structure), acne, wound healing, and overall skin health.[5] Sulfur provides structure and elasticity at a molecular level. Disulfide bonds link skin proteins, like collagen and elastin, and are critical for skin's strong, yet flexible characteristic.[1] These bonds can be stretched, yet retain shape once released. Additionally, as an integral part of the antioxidant and detoxification processes, sulfur is necessary to protect and maintain proper skin growth.[6]

Similarly, sulfur supports connective tissue. Tendons and ligaments rely on sulfur for proper cross-linking (disulfide bonds) in addition to extracellular matrix proteins like glycosaminoglycan's (GAGs) and hyaluronic acids (HA), which are highly sulfonated, and provide strength and cushion.[3,7]

In the liver, sulfur plays two critical roles. As a significant component of glutathione, the most prevalent antioxidant in the body, sulfur helps the body react to oxidative stress and maintain homeostasis, which is particularly relevant to exercise and aging. And as part of phase 2 detoxification, sulfur is essential to the metabolism and excretion of harmful substances.[6,8]

There are many other roles, such as free radical scavenging, and regulation of gene expression.[6] Further, sulfur indirectly influences all processes of compounds or metabolites in which it is a key component. This includes n-3 and n-6 polyunsaturated fatty acids, and minerals such as Selenium, Zinc, Copper, and Magnesium.[3] Bottom line, the role of sulfur in the body is broad, impactful, and should not be underestimated.

DO WE GET ENOUGH SULFUR IN THE DIET?

It is vital that there is a good supply of sulfur in the diet to maintain synthesis of the SAAs. Methionine, cannot be synthesized in the body and therefore directly relies on an adequate intake of protein. While cysteine is synthesized in the body; the process requires a steady supply of sulfur.[8]

It's assumed that sulfur intake in the diet is adequate. However, this is based on SAAs, not sulfur directly.[2] Further, the requirements for SAAs are based on nitrogen balance and likely under-estimate the dietary need for sulfur.[3] As such, there is increasing evidence that our needs for methionine, specifically, are not being met through diet.[3] This is further complicated by the admission that intakes don't have to be deficient to cause physiological disruption. Even marginally sufficient intake may not be enough. Furthermore, continued evidence to show that dietary intakes have declined due to modern agricultural processes.[2,9] The perception that supply is adequate is, therefore, problematic.

OPTIMSM® AS A SOURCE OF SULFUR

MSM, or methylsulfonylmethane, a popular food supplement, is composed of sulfur, oxygen, and methyl groups.[2] It is naturally found in a variety of foods, such as milk, fruits, tomatoes, corn, coffee, and tea.[10] However, supplemental intake may prove necessary, given the confusion as to how much sulfur is required in the diet.

Several studies have demonstrated that sulfur from MSM can be incorporated into SAAs, proteins, and various tissues.[11,12] When consumed in doses ranging between 1.0 g/day and 6.0 g/day over several weeks to months, no significant adverse events have been reported.[13–15] Furthermore, MSM has been shown to benefit joint health (joint pain, swelling, and improved mobility),[16–20] improve skin quality (elasticity, firmness, and reduced wrinkles),[21] suppress seasonal allergic rhinitis,[22,23] and reduce exercise-induced oxidative stress and muscle damage in humans.[24,25] This is likely a result of MSM acting as a sulfur donor in addition to stimulating glutathione and other relevant molecules to reduce the impact of inflammation and oxidative stress.

OptiMSM®, the only branded and U.S.-manufactured form of MSM, is produced by Bergstrom Nutrition and is utilized in the majority of research on MSM and its benefits. Because it is the only distilled MSM in the world, the purity, consistency, and safety of OptiMSM are unmatched, and the best option for research. A recent study proved rapid absorption of OptiMSM and incorporation into tissue proteins.[12] OptiMSM provides the body an easily accessible pool of sulfur which spares the essential sulfur-containing amino acids (SAAs) methionine and cysteine from being metabolized for their sulfur. It's role as a sulfur donor, and its ability to preserve SAAs explains the broad range of health benefits observed with OptiMSM supplementation. Bergstrom Nutrition, who sponsored the study, continues to invest in research to support the efficacy, safety, and applications of OptiMSM.

While there is a significant amount of research to support the role of MSM in human health,[13] admittedly, less has been reported on the specific role of the sulfur per se. However, given the extent to which MSM is shown to influence various aspects of human health, there is a growing appreciation of its "protective" role in the diet. This is particularly relevant to active nutrition and active-aging where consumers are looking for solutions to help them remain "ageless."

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