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Dimethyl Sulfoxide (DMSO): Benefits, Uses and Side Effects

Analysis by Dr. Joseph Mercola | November 08, 2024

STORY AT-A-GLANCE

- DMSO is an organosulfur compound used as a topical pain reliever and anti-inflammatory agent. It activates cellular stress responses at low to moderate levels, boosting resilience against future threats
- Research shows DMSO inhibits cancer cell growth and triggers apoptosis in various cancer cell lines, suggesting promise as a targeted therapy for slowing or stopping cancer progression
- In a mouse model of Alzheimer's, low-dose DMSO improved visual function, likely due to its antioxidant properties. It may be useful as an early intervention in neurodegenerative diseases
- DMSO is related to MSM, which has shown benefits for joint health. It also exhibits antibacterial properties, inhibiting growth of various bacterial strains at relatively low concentrations
- While promising, DMSO has side effects including garlic-like odor and skin irritation. It increases absorption of other substances and may interact with certain medications, necessitating caution in its use

You may have heard of dimethyl sulfoxide (DMSO), an organosulfur compound, as a remedy for joint pain or inflammation. DMSO is produced both naturally and synthetically. It's found in trace amounts in certain foods and widely used as a solvent in scientific research and industrial processes due to its ability to dissolve organic compounds.

In medicine, DMSO is used as a topical pain reliever and anti-inflammatory agent. It's approved by the U.S. Food and Drug Administration for the treatment of interstitial cystitis, also known as bladder pain syndrome, a chronic condition that causes bladder pain, pressure and discomfort.[1]

DMSO is also used as a cryoprotectant to prevent cell damage during freezing.[2] This compound shows promise for benefitting many health conditions, but it has a complex relationship with your cells. Recent research on yeast cells, for instance, reveals that DMSO's effects depend heavily on concentration and exposure time, influencing whether the compound is healing or harmful.[3]

DMSO: A Cellular Stressor That Builds Resilience

At low and moderate levels, DMSO activates cellular stress responses that boost your resilience. However, at higher concentrations or with prolonged exposure, it impairs cell growth and may even prove toxic. Too little DMSO didn't trigger the response, while too much overwhelmed the cells' defenses.

The key lies in how DMSO interacts with cell membranes and energy production. Short-term exposure to moderate DMSO levels didn't significantly damage yeast cell membranes or reduce their metabolic activity.[4] But it did trigger stress response genes, priming cells to better handle future threats, explaining some of DMSO's protective effects.

The study found that DMSO activated yeast cells' environmental stress response (ESR) program at certain concentrations. This cellular alarm system, triggered by various mild stresses, prepares cells to better handle future, potentially more severe challenges.

It's a bit like how exercise stresses your body in the short term but ultimately makes you stronger. This stress response activation helps explain why DMSO is helpful in cryopreservation or as a protective agent against radiation damage.

At higher doses though, DMSO began to interfere with cell division and survival. Your cells' preferred energy source plays a surprisingly important role in how well they

tolerate DMSO. The study found that yeast cells using primarily aerobic respiration, which relies heavily on oxygen, were most sensitive to DMSO's toxic effects. In contrast, cells using fermentation or a mix of fermentation and respiration fared better.

This difference likely stems from how DMSO interacts with mitochondria, your cell's power plants. Cells with highly active mitochondria are more vulnerable to factors that disrupt their delicate balance, including DMSO at higher doses. The compound may destabilize mitochondrial membranes, leading to increased production of harmful reactive oxygen species (ROS).

The researchers found that lowering oxygen levels in the yeast's environment increased their DMSO tolerance across the board. This suggests that DMSO's effects are closely tied to oxygen-dependent processes in your cells.

An Ally in the Fight Against Cancer

Studies reveal DMSO has another unexpected benefit: fighting cancer. Researchers investigated DMSO's impact on both leukemia cells (representing blood cancers) and epithelial cancer cells (representing solid tumors).[5] They found that DMSO significantly inhibited cell growth in all tested cancer cell lines, including MV4-11 and TF-1a leukemia cells, as well as Hep-G2 liver cancer cells and MCF7 breast cancer cells.

This inhibition was both dose and time-dependent, with noticeable effects starting at concentrations as low as 2% DMSO. At 10% DMSO, growth inhibition reached up to 69% in some cell lines after 72 hours of exposure. This suggests DMSO could be used as a targeted therapy to slow down or stop cancer growth.

The study didn't just stop at observing growth inhibition — it explored how DMSO affects cancer cells. Using a trypan blue assay, which distinguishes between live and dead cells, the researchers found that 5% DMSO increased cell death rates from about 2% to 3% to 15% to 19% in leukemia cells after 48 hours. This indicates that DMSO isn't just slowing cancer cell division; it's actively killing these harmful cells.[6]

Under the microscope, DMSO-treated cancer cells showed significant changes in morphology. The cells shrank, their density decreased and, most importantly, their nuclei began to fragment. These nuclear fragments, visible as multiple dots within nondividing cells, are a hallmark of apoptosis, or programmed cell death.

The higher the DMSO concentration, the more pronounced these effects became. Even the adherent epithelial cancer cells, which normally form a smooth monolayer in culture, began to detach and cluster when exposed to DMSO. These observations suggest that DMSO could be triggering the cancer cells' built-in self-destruct mechanisms.

DMSO Activates Cancer Cells' Self-Destruct Sequence

Digging deeper into the molecular mechanisms, the researchers uncovered how DMSO sets off a cascade of events leading to cancer cell death. They found that DMSO significantly decreased levels of CDK2 and cyclin A — crucial proteins that regulate cell division. The CDK2-cyclin A complex, which plays a key role in driving cells from one phase of the cell cycle to the next, was particularly affected.[7]

By disrupting these regulators, DMSO effectively puts the brakes on cancer cell proliferation. But perhaps most tellingly, DMSO triggered DNA fragmentation in the treated cancer cells. This is considered a definitive sign of apoptosis, as it represents the cell systematically destroying its own genetic material. The researchers confirmed this by detecting increased levels of activated caspase 3, an enzyme central to the execution of apoptosis.

Interestingly, they didn't see activation of caspase 9, suggesting that DMSO triggers apoptosis through the extrinsic pathway rather than the intrinsic mitochondrial pathway. This specific mechanism could be crucial in developing targeted cancer therapies that don't harm healthy cells.

The study suggests that even at relatively low concentrations, DMSO has profound effects on cancer cell health and survival. Moreover, because DMSO is already widely

used and well-tolerated in many medical contexts, it could potentially be fast-tracked for cancer treatment studies.

DMSO Improves Visual Function in Alzheimer's Model

Early animal studies raised some concerns about DMSO causing eye problems, particularly affecting the lens. These findings were not found to translate to humans,[8] however, and recent research offers a more reassuring perspective for those considering DMSO as part of their health regimen.

Research using a mouse model of Alzheimer's revealed that DMSO, even at very low concentrations, significantly improves visual function.[9] The study focused on 5xFAD mice, which are genetically engineered to develop Alzheimer's-like symptoms. These mice typically experience a decline in contrast sensitivity, an important aspect of vision that's also affected in human Alzheimer's patients.

Remarkably, when treated with just .01% DMSO in their drinking water, the mice showed a marked improvement in their contrast sensitivity. This improvement was comparable to the effects seen with R-carvedilol, a drug specifically being investigated for Alzheimer's treatment.

The fact that such a low dose of DMSO could produce these benefits is particularly intriguing, as it suggests DMSO's therapeutic effects may have been underestimated in previous research where it was used merely as a vehicle for other drugs.

Early Intervention Potential with DMSO

The study's findings point to DMSO's antioxidant properties as a mechanism for its beneficial effects. DMSO is well-known as a powerful scavenger of hydroxyl free radicals, which contribute to oxidative stress, a factor in the development and progression of Alzheimer's disease. The researchers observed that DMSO treatment corrected abnormalities in the retina that are associated with oxidative stress.

Specifically, they found that DMSO normalized the thickness of a particular layer in the retina (the ELM-RPE layer) that becomes contracted in the presence of oxidative stress. This correction suggests that DMSO is actively combating oxidative damage in the retinal tissue. Given that your retina is essentially an extension of your brain, these findings imply that DMSO could be providing similar protective effects throughout the central nervous system.

This is particularly exciting because oxidative stress is believed to be one of the earliest events in the development of Alzheimer's, occurring even before the appearance of characteristic amyloid plaques and tau tangles.

Given these findings, there's potential for DMSO as an early intervention in Alzheimer's disease. The study focused on relatively young mice (4 months old) that were just beginning to show signs of visual impairment.[10] The fact that DMSO was able to improve function at this early stage suggests it could be particularly valuable as a preventative measure or early treatment.

Early intervention is crucial in Alzheimer's disease, as by the time cognitive symptoms become apparent, significant brain damage has often already occurred. If DMSO can help protect against oxidative stress and maintain neuronal health from the earliest stages of the disease process, it could slow or even prevent the progression to full-blown Alzheimer's.

Moreover, the safety profile of DMSO at low doses is well-established, making it an attractive option for long-term use in at-risk individuals.

Beyond the Brain: DMSO's Wider Implications

While this study focused on visual function and retinal health, its implications reach far beyond Alzheimer's disease. The protective effects of DMSO observed in the retina extend to other tissues and organs throughout your body. Oxidative stress is implicated in a wide range of age-related conditions, from cardiovascular disease to arthritis.

For instance, DMSO is closely related to another compound that could benefit your joint health: methylsulfonylmethane (MSM). DMSO is a precursor to MSM, and both compounds share similar sulfur-based structures. Like DMSO, MSM has been shown to have significant anti-inflammatory effects, especially for joint pain. A randomized, double-blind, placebo-controlled trial in Japan explored the effects of MSM on mild knee joint pain in healthy individuals.[11]

Participants who took 2 grams of MSM daily for 12 weeks experienced significant improvements in their knee health compared to those taking a placebo. The study used a comprehensive measure of knee health (the Japanese Knee Osteoarthritis Measure) and found that MSM not only improved knee-specific symptoms but also enhanced overall health conditions.

This research suggests the sulfur-containing compounds in both DMSO and MSM may offer a range of health benefits, from neuroprotection to joint pain relief.

Given that DMSO can be converted to MSM in your body, using DMSO might provide some of the joint health benefits associated with MSM, in addition to its neuroprotective effects and anti-inflammatory and pain-relieving properties. These actions make DMSO an intriguing compound for overall health maintenance as you age.

DMSO's ability to inhibit and kill a range of bacteria — even at low concentrations — has also been known for decades. Researchers tested DMSO against several bacterial strains, including Staphylococcus aureus, β-hemolytic streptococci, Corynebacterium acnes, Escherichia coli and Proteus species.[12]

They found that a 20% concentration of DMSO was enough to inhibit the growth of all these bacteria. So, even at relatively low concentrations, DMSO can effectively stop bacterial reproduction.

DMSO Risks, Dosing Suggestions and Other Considerations

While DMSO shows promising benefits, it's important to approach its use with caution and awareness. As with any supplement or treatment, DMSO has side effects and

contraindications that you need to be aware of. The most common side effect is a garlic-like taste or breath odor, which occurs because DMSO breaks down into dimethyl sulfide in your body. Some people may also experience skin irritation when DMSO is applied topically.

DMSO also increases the absorption of other substances through your skin, amplifying the effects of medications. This means you need to be careful about what comes into contact with your skin when using DMSO topically. It's also important to note that DMSO interacts with certain medications, including blood thinners and steroids.

Additionally, high concentrations may cause liver damage if used improperly. Pregnant women and those with liver disease should use caution when considering DMSO. As always, I recommend consulting with a holistic health care practitioner to determine if DMSO is right for you.

Proper product selection and dosing are key to getting the best results. **A Midwestern Doctor recommends** looking for DMSO that has at least 99.9% purity and, if liquid, is stored in glass. For topical dosing, start with 70% and dilute it 50/50 with water. Gradually work your way up to the full-strength product as long as no skin irritation occurs. You can also progress to a 100% DMSO product if you have thick scars or are using it for specific health conditions.

For oral dosage, a typical starting dose is 0.5 to 1 teaspoon (of 70% or 100%). You may gradually increase the dose as long as you are tolerating it well. The maximum safe dosage is up for debate, but generally 3 teaspoons is considered the upper limit. Keep in mind that since DMSO has an unpleasant taste, you'll likely want to mix it with milk or juice when consuming it orally. Be sure to mix it well so the DMSO doesn't settle at the bottom.

Remember, while DMSO shows promise, it's not a miracle cure. It should be considered as part of a holistic approach to health, including a nutrient-dense diet, regular exercise, stress management and other lifestyle factors that support your overall well-being. Used responsibly and under proper guidance, DMSO could be a valuable tool in your health

arsenal, particularly for its antioxidant, neuroprotective, anticancer and anti-inflammatory properties.

Sources and References

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