Regenerative Powers of TURMERIC

GreenMedinfo®

The Science of Natural Healing

REGENERATIVE POWERS OF TURMERIC

By GreenMedInfo Research Group

CONTENTS

REGENERATIVE POWERS OF TURMERIC

This ancient healing spice is an anti-inflammatory and antioxidant powerhouse, bringing body-wide benefits with a particular importance for neuroregeneration, courtesy of an often-overlooked compound called ar-turmerone.

BY GREENMEDINFO RESEARCH GROUP

Turmeric has earned superstar status in the spice aisle, with a resumé so impressive it boasts of 281 distinct pharmacological actions — from anti-inflammatory and antioxidant properties to acting as an anticarcinogenic and antidepressive agent.[1]

There's a reason why turmeric (Curcuma longa L.) has been a featured part of Ayurvedic medicine for 5,000 years[2] — as a food ingredient, dye and a medicinal remedy — and has been the subject of thousands of modern-day research studies.

It's an adaptogenic herb, which means it's useful for promoting balance and homeostasis in your body while boosting your resilience to stress.[3] Its name, turmeric, comes from the Medieval Latin term terra merita, which means "deserving earth." Traditionally, turmeric was used for gastrointestinal issues, inflammatory conditions, liver disorders, infectious diseases, gynecological problems, asthma, dental problems and more.[4]

In traditional Chinese medicine, turmeric was also valued for cardiovascular issues, respiratory disorders, digestive conditions and liver health. While turmeric as a spice is still relatively uncommon in the Western world, its popularity as a nutraceutical has flourished, making it one of the most successful natural health products in the U.S. since 2013.[5]

Much of the fanfare surrounding turmeric is focused on curcumin, one of its active constituents that's well known for its anti-inflammatory and antioxidant properties.[6] Curcumin is, indeed, notable in the realm of therapeutic substances, but it's not turmeric's only claim to fame.

There's good reason to also include whole turmeric, which lends the bright yellow color to many curry dishes, in your diet, as it contains beneficial compounds beyond curcumin, including aromatic turmerone (ar-turmerone), a fat-soluble compound that supports regeneration in neurologic disease.[7]

WHAT IS AR-TURMERONE?

Ar-turmerone is a bioactive compound in turmeric that's present in higher concentrations than curcumin.[8] The spice turmeric typically contains only about 3.14% curcumin, while a 2016 study found that, of the 50 compounds present in turmeric extract, ar-turmerone made up 20.5%.[9]

Researchers with The University of Texas MD Anderson Cancer Center pointed out in 2013 that even curcumin-free turmeric has powerful anti-inflammatory and anticancer activities, part of which are due to ar-turmerone.[10] Back in 1992, Brazilian researchers revealed that ar-turmerone

neutralized the hemorrhagic activity and lethal effect of two types of snake venom in mice, showing promise for its use as "a potent antivenom against snakebite."[11]

Ar-turmerone is also an effective antifungal against Candida albicans and has potent antibacterial activity. A review published in Molecular Nutrition & Food Research delved into ar-turmerone's anticancer and anti-inflammatory properties.

In terms of anticancer effects, "turmerones exhibit a profile of activity against cancer cells that is different from that of curcuminoids," which are the family of polyphenol compounds to which curcumin belongs. According to the review, ar-turmerone's anticancer effects include:[12]

Inhibited the growth of cancer cells	Suppressed TPA-induced invasion, migration and colony formation in breast cancer cells (TPA, or 12-O-tetradecanoyl-phorbol-13-acetate, is a tumor promoter)
Inhibited growth in leukemia cells, while inducing DNA fragmentation in the cancer cells	Induced DNA fragmentation in human breast cancer cells
Stimulated the proliferation of human peripheral blood lymphocytes, a type of white blood cell that's crucial for the immune response[13]	Induced apoptosis in human liver cancer cells
Prevented inflammation-induced cancer in mice	

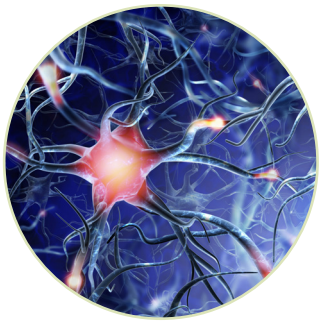
Ar-turmerone's anti-inflammatory effects are equally impressive and include:[14]

Suppressed the adhesion of inflammatory cells to endothelial cells	Inhibited the expression of inflammatory COX-2 in breast cancer cells
Inhibited the expression of pro-inflammatory cytokines and chemokines in the central nervous system's microglial cells	More potent than aspirin in inhibiting platelet aggregation

AR-TURMERONE'S REGENERATIVE, NEUROGENIC BENEFITS

Ar-turmerone shows promise for regeneration of nerve cells and may support neurologic disease.[15] It's known, for example, that ar-turmerone blocks the activation of microglial cells, which play a role in immune function in the brain and, when activated, are neuroinflammatory.[16]

This property alone makes ar-turmerone potentially useful for treating neurodegenerative disease, as microglia activation is a hallmark of an inflammatory response in the central nervous system linked to neurologic disorders such as stroke, traumatic brain injury, Parkinson's disease and Alzheimer's disease.[17]



However, ar-turmerone has also been found to induce neural stem cell proliferation.[18] Neural stem cells (NSCs) have regenerative potential, and targeted activation of NSCs enhances self-repair and the recovery of function in human brains following stroke and neurodegeneration. NSCs are also known to interact with microglia.

NSCs are activated in response to injury and, via their production of neurotrophic factors and cytokines, including brain-derived neurotrophic factor, play a significant role in regeneration.[19]

Researchers with the department of neurology at University Hospital of Cologne in Germany looked into the effects of ar-turmerone on NSCs, finding that it increased the number of NSCs in cell culture and adult rat brains in vivo and led to the promotion of neurogenesis.

In some cases, ar-turmerone increased NSC proliferation by up to 80%, without affecting cell death.[20] The turmeric compound also enhanced neuronal differentiation of NSCs, an important step that can provide essential sources of neural cells in cases of Alzheimer's, Parkinson's or spinal cord injury.[21] As noted by the study's lead author, Adele Rueger:[22]

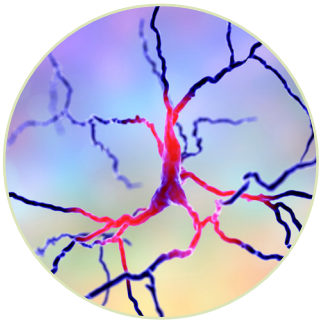
"While several substances have been described to promote stem cell proliferation in the brain, fewer drugs additionally promote the differentiation of stem cells into neurons, which constitutes a major goal in regenerative medicine. Our findings on aromatic turmerone take us one step closer to achieving this goal."

AR-TURMERONE IS A NEUROPROTECTIVE POWERHOUSE

Another sign of ar-turmerone's neuroprotective prowess can be found via its effects on dopaminergic neurons — the primary source of dopamine in the central nervous system. Dopaminergic neurons are important for a number of brain functions, including voluntary movement, and play a role in behavioral processes including mood, addiction, reward and stress.

A loss of dopaminergic neurons in the midbrain's substantia nigra is associated with Parkinson's disease.[23] Researchers from Kumamoto University in Japan revealed that two ar-turmerone analogs — ar-atlantone (Atl) and analog 2 (A2) — reversed dopaminergic neurodegeneration that was triggered by microglial activation.[24] However, the neuroprotection was not due to the inhibition of microglial activation but, rather, is believed to be due to a direct neuroprotective effect on dopaminergic neurons.

According to the study, the ar-turmerone analogs may have inhibited dopaminergic neurodegeneration by the activation of nuclear factor E2-related factor 2 (Nrf2), which is known to activate several antioxidative genes that prevent oxidative stress.[25] The A2 analog, in particular, also had both anti-inflammatory and neuroprotective activities, with the researchers noting that it shows promise for treating Parkinson's disease.



Oral ar-turmerone was previously shown to have an antidepressant effect in mice, leading the researchers to suggest that A2 would also be able to penetrate the blood-brain barrier and be effective as an orally administered agent.[26] Study author Takahiro Seki added in a news release that ar-turmerone may also be useful for diseases beyond Parkinson's:[27]

"Our study elucidated a new mechanism by which ar-turmerone and its derivatives directly protect mesencephalic slice dopaminergic neurons, independent of their previously reported anti-inflammatory effects on microglia. We showed that two derivatives, Atl and A2, exhibit neuroprotective effects by increasing the expression of antioxidant proteins through the activation of Nrf2.

In particular, the analog A2 identified in this study is a potent activator of Nrf2 and is assumed to have a strong antioxidant effect. We think it is possible that this compound may be a new dopaminergic neuroprotective agent for Parkinson's disease treatment, and it could also be used to treat other diseases caused by oxidative stress, such as liver and kidney diseases."

In another study, ar-turmerone reversed memory disturbance in an animal model of Alzheimer's disease, while also normalizing glucose intake and metabolism in the brain. Brain damage was significantly limited by ar-turmerone, which once again was shown to inhibit the activation of microglia and the generation of inflammatory cytokines.[28]

Ar-turmerone also increased the survival of neurons following activity deprivation, preventing apoptosis, or programmed cell death,[29] and produced antidepressant-like effects in mice after one week of administration.[30]

With its unique ability to boost the proliferation and differentiation of NSCs, along with its ability to reduce neurological inflammation, ar-turmerone's potential for treating neurodegenerative disease and even traumatic brain injury is impressive.[31] Further, it's been found that NSCs in the brain can boost myelination, with German researchers noting the "significant potential of NSCs to contribute to myelin repair activities" and myelin regeneration.[32]

The adult brain requires new myelin for learning,[33] so it's possible that neuroprotective substances like ar-turmerone may be useful not just for neurodegenerative disorders but for maintaining and protecting cognitive function in healthy brains, too.

AR-TURMERONE IS A WHOLE-BODY TONIC

While much of the research into ar-turmerone has focused on its neurogenic benefits, ar-turmerone has body-wide benefits, including anti-inflammatory, antioxidative and anti-platelet properties.[34]

When combined with curcumin, ar-turmerone was found to "abolish" tumor formation in mice with colon cancer at both low and high doses. Ar-turmerone also suppressed adenoma multiplicity by 73%, with researchers suggesting ar-tumerone is "a novel candidate for colon cancer prevention" and, when used with curcumin, "may become a powerful method for prevention of inflammation-associated colon carcinogenesis."[35]

The anticonvulsant properties of ar-turmerone have also been recognized, with research supporting its potential use for the treatment of epilepsy,[36] and ar-turmerone is also anti-mutagenic.[37] Its chemopreventive properties have been well explored, with research showing it can induce apoptosis in human leukemia cells and has immunostimulatory effects. As written in a Food and Chemical Toxicology study:[38]

" ... the curcuminoids (curcumin, demethoxycurcumin and bisdemethoxycurcumin) and a-turmerone isolated form CL [Curcuma longa] lipophilic fraction significantly inhibited proliferation of cancer cells in a dose-dependent manner ... "

Further, in addition to being a potent antifungal against Aspergillus flavus[39] — a human allergen, pathogen and the major producer of aflatoxin — ar-turmerone is effective as a mosquito repellant, working significantly better than the toxic chemical DEET at preventing bites.[40]

TURMERIC'S REGENERATIVE POWERS

While using targeted supplements can give you access to compounds like ar-turmerone at concentrations that are difficult to get via your diet, it's often beneficial to consume foods like turmeric whole, as you gain access to their many varied bioactive compounds and synergistic effects. Curcumin in turmeric, for instance, is also a powerful regenerative substance that may:

- Support "essentially perfect" skin regeneration following surgery[41]
- Enhance the regeneration of beta cells in the pancreas to benefit Type 1 diabetes[42]
- Promote peripheral nerve regeneration, both in normal conditions and after injury[43]
- Help repair and regenerate liver tissue[44]

While ar-turmerone shows promise especially for its brain-protective potential, curcumin offers numerous health benefits for healthy people, including at a low dose, such as 80 milligrams (mg) a day. When people between the ages of 40 and 60 consumed this low dose of curcumin, in a special lapidated form to increase absorption, for four weeks, they experienced:[45]

- Lower triglyceride levels
- Higher salivary radical scavenging capacities, suggesting direct antioxidant action
- Lower beta amyloid protein concentrations, which is one way the compound may work against the development of Alzheimer's disease
- Increased nitric oxide, which is beneficial for blood pressure
- Increased plasma myeloperoxidase, which could indicate strengthened cellular immunity

As a whole, turmeric and its bioactive constituents form a formidable health ally that may ward off a number of chronic conditions, such as:[46]

Oxidative stress, via its antioxidant properties	Inflammation and inflammatory diseases, via its anti-inflammatory and immunomodulatory effects
Allergies, via anti-allergic properties	Cardiovascular diseases, due to being hypolipidemic, atheroprotective and cardioprotective
Diabetes, due to its hypoglycemic, antiglycation and antidiabetic properties	Cancer, via antitumor, pro-apoptotic, antimet-astatic and anticancer effects
Neurodegenerative diseases, as turmeric is neuroprotective	Depression, via antidepressant effects
Liver diseases, due to hepatoprotective effects	

A water-soluble antioxidant in turmeric — turmerin — is also worthy of mentioning; it's been found to exert both anticancer and anti-inflammatory effects.[47]

CURCUMIN'S REGENERATIVE AND ANTIAGING POTENTIAL

Curcumin is also notable for its regenerative powers, in part due to its effects on stem cells. Stem cells can be described as "raw materials" for your body — cells from which other more specialized cells are generated.[48] A key part of regenerative medicine lies in guiding stem cells to differentiate into specific other cells that can regenerate and repair diseased and damaged tissue.

As noted in the journal Phytotherapy Research, "In adults, progenitor and stem cells act as a repair and replenish system for the body tissues."[49] Natural compounds have been explored for their support of stem cells, and curcumin is known to exert protective effects on stem cell proliferation, differentiation and aging.

Curcumin also has a synergistic effect with a set of stem cells called mesenchymal stromal cells (MSCs), supporting the recovery of tissue after injury.[50] In 2019, researchers with Tabriz University of Medical Sciences in Iran compiled the molecular and cellular mechanisms of curcumin on stem cells, revealing:[51]

- **ANTIOXIDATIVE EFFECTS —** One of the limitations of MSCs as stem cell therapy is that they have a low survival rate after being transplanted. Curcumin plays a protective role against oxidative injury and may improve cell viability.

  Oxidative stress not only inhibits the differentiation of stem cells but leads to cell injury and apoptosis. Curcumin acts as an antioxidant, protecting stem cells against oxidative stress.

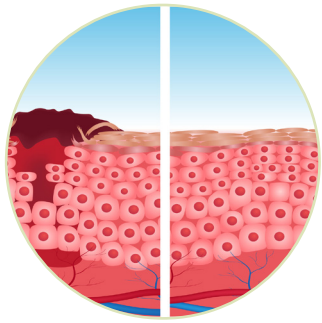
- **STIMULATION OF PROLIFERATION AND DIFFERENTIATION —** Curcumin helps to stimulate proliferation and differentiation of stem cells, with low concentrations of curcumin leading to a stimulatory effect on stem cell growth. According to the Phytotherapy Research review, curcumin induces stem cell potency:[52]

  "Curcumin impacts stem cells' self-renewal via stimulation of proliferation, stemness acting signals, cell growth, telomerase activity, and migration. Curcumin can increase PI3K activation and its downstream mediators, leading to subsequent induction in the expression of stemness genes and proliferation-related transcription factors."

- **REGENERATIVE EFFECTS —** Stem cells' ability to differentiate into different cell types brings the possibility for regeneration to occur, with injured tissue self-healing and regaining its structure and functionality. In the case of osteoarthritis and rheumatoid arthritis, the presence of pro-inflammatory cytokines inhibits progenitor cells' ability to differentiate, hindering the regeneration process in damaged cartilage.

  Curcumin, however, establishes an anti-inflammatory microenvironment that makes stem cell differentiation possible and helps to regulate cartilage homeostasis.

- **WOUND HEALING —** Curcumin's anti-inflammatory, antioxidant and antimicrobial properties make it stand out for wound-healing potential, and an animal study showed that curcumin treatment encourages the proliferation of epidermal stem cells in skin burns. In addition, curcumin generated a regenerative immune microenvironment that supported adult cutaneous wound healing.



- **STEM CELL ANTIAGING —** Curcumin may help improve the lifespan of certain stem cells, helping to bypass one of the primary problems with cell therapy — aging. Its protective effects are so strong that curcumin can even inhibit arsenic poisoning, which is known to disrupt stem cell homeostasis.

- **NEUROGENESIS —** Curcumin may help stimulate neurogenesis in the adult brain's hippocampus, offering a neuroprotective effect that may protect against Huntington's disease, Parkinson's disease and other neurodegenerative diseases as well as support normal brain health.

TURMERIC SUPPORTS YOUR HEART AND METABOLIC HEALTH

Traditionally, turmeric was valued as an overall health tonic. In traditional Chinese medicine, it was also used for more complex chronic illnesses, including those relating to the cardiovascular system.[53]

While the exact mechanisms behind turmeric's cardioprotective effects remain unclear, it's believed that its antioxidant and anti-inflammatory effects are involved, particularly as they relate to the regulation of cell signaling pathways such as mitogen-activated protein kinase (MAPK), nuclear factor kappa B (NF-κB) and nuclear factor erythroid 2-related factor 2–Kelch-like ECH-associated protein 1 (Nrf2-Keap1).

As noted in a 2021 review by the University of British Columbia, Vancouver, Canada, researchers, "These molecular redox signaling pathways combat oxidative stress and inflammation — two highly recognized factors associated with the etiology and pathogenesis of CVDs [cardiovascular diseases]."[54]

Curcumin also has antidiabetes properties and may ward off the development of metabolic syndrome, additional risk factors for cardiovascular disease. "Of particular interest," they explained, "is that turmeric, curcumin, and curcuminoids are all effective in preventing CVD in both healthy individuals, as well as those individuals that have underlying CVD risk factors."[55]

In other words, turmeric isn't only for those with chronic disease; it's an effective wellness promotor in people without disease. In relation to metabolic health, turmeric, curcumin and the other bioactive compounds it contains are protective against Type 2 diabetes by upregulating insulin, enhancing insulin sensitivity and lowering cellular uptake of glucose.[56]

Additional benefits of turmeric and curcumin have been noted for people with metabolic syndrome, including:[57]

- Improved body mass index (BMI), waist circumference and body fat percentage
- Lower low-density lipoprotein cholesterol and C-reactive protein levels
- Improved oxidative stress and inflammatory status in those who supplemented (short-term) with a curcuminoid-piperine combination (piperine, which comes from black pepper, improves the bioavailability of curcuminoids)

HOW TO ENHANCE TURMERIC ABSORPTION

Turmeric compounds, particularly curcumin, have generally poor bioavailability, which means it may be difficult to get therapeutic amounts from eating turmeric alone. Supplements are available, which can give you greater concentrations, but keep in mind that some of turmeric's benefits have been demonstrated even at very low doses.

The black pepper compound piperine increases curcumin absorption by 2,000%,[58] so eating turmeric along with black pepper may help to enhance curcumin absorption. Curcumin is also fat-soluble, so eating turmeric in a meal with healthy fats is recommended.

Combining turmeric with quercetin-rich foods, which include onions, kale, blueberries, apples and tomatoes, is also wise, as quercetin also enhances the bioavailability of curcumin.[59]

Heating turmeric during cooking is another trick, as heat has been found to increase the solubility of curcumin by 12-fold and that of turmeric by three-fold.[60] The traditional use of turmeric for curry naturally comprises all of these bioavailability enhancers — pepper, quercetin-rich foods and heat.

Another option is turmeric oil. Ar-turmerone is the major component of turmeric oil, which has been found to enhance the bioavailability of curcumin by sevenfold. "This may be because," researchers explained in Molecular Nutrition & Food Research, "ar-turmerones are known to enhance the absorption of curcumin by the cells by modulating the activity of P-glycoprotein."[61]

It's being increasingly appreciated that using turmeric in a form that contains both curcumin and ar-turmerones may offer benefits that can't be found from curcumin alone. For instance, ar-turmerones increase the amount of curcumin transported to certain human intestinal epithelial cells and may also affect the absorption of curcumin.

"These findings suggest the potential use of turmeric extract (including curcumin and turmerones), rather than curcumin alone, for treating diseases," according to a study in the Journal of Medicinal Food.[62] It's also been suggested that curcumin may exert many of its health-enhancing benefits due to its positive gastrointestinal effects.

That is, even with poor bioavailability and limited systemic tissue distribution, curcumin may benefit health by supporting the gastrointestinal tract, which has far-reaching health implications. In the gastrointestinal tract, curcumin offers the following beneficial effects; "positive changes in these areas can have wide-ranging influences on both intestinal and extraintestinal diseases, and

therefore presents as a possible mechanism behind curcumin's therapeutic efficacy," researchers explained in Advances in Nutrition.[63]

Antioxidant	Antibacterial	Antiparasitic
Antifungal	Anti-inflammatory	Immune benefits
Modulates intestinal permeability	Influences the composition of gut microbiota	May reduce the anaphylactic response from oral food allergens

SIMPLE WAYS TO ADD TURMERIC TO YOUR DIET

If you like curry, you'll love turmeric, as it's responsible for the pungent, earthy flavor of the dish. On its own, turmeric can be described as bitter, woody and slightly peppery, but it's not as spicy as its cousin, ginger.

Often used to add depth to dishes, turmeric pairs well with everything from root vegetables to sweeter spices like cinnamon, making it an extremely versatile ingredient in your kitchen. Some of the more popular ways to get more turmeric in your diet include adding it to:

Eggs or scrambled tofu	Homemade salad dressings
Soups, stir-fries, stews, vegetable dishes and curries	Smoothies
Homemade hummus, pickles, relish, chutney and mustard	Lemonade
Golden milk or "turmeric lattes"	Chicken salad or rice dishes

If you're new to golden milk, this is a traditional way to enjoy turmeric that can be tweaked to fit your personal dietary preferences. It's a mixture of spices, including turmeric, cinnamon, ginger and black pepper, and milk, which can be grass-fed cow's milk or coconut milk. Honey and coconut oil can also be added. A simple golden milk recipe, adapted from Epicurious, follows:[64]

GOLDEN MILK

INGREDIENTS:

- 1 cup grass fed milk or coconut milk
- 1 (3-inch) cinnamon stick
- 1 (1-inch) piece turmeric, unpeeled and thinly sliced, or 1/2 teaspoon dried turmeric
- 1 (1/2-inch) piece ginger, unpeeled and thinly sliced
- 1 tablespoon honey
- 1 tablespoon coconut oil
- 1/4 teaspoon whole black peppercorns
- Ground cinnamon (for serving)

METHOD:

- Whisk coconut milk, cinnamon, turmeric, ginger, honey, coconut oil, peppercorns, and 1 cup water in a small saucepan; bring to a low boil.
- Reduce heat and simmer about 10 minutes.
- Strain through a fine-mesh sieve into mugs and top with a dash of cinnamon.

When it comes to turmeric's healing and regenerative potential, this is only the beginning. Turmeric has been explored for its use in more than 900 diseases, which you can explore more in-depth at GreenMedInfo.com.

REFERENCES

1 GreenMedInfo.com, Turmeric, Pharmacological Actions https://www.greenmedinfo.com/substance/turmeric

2 Frontiers in Pharmacology September 15, 2020 https://www.frontiersin.org/articles/10.3389/fphar.2020.01021/full

3 J Nat Med. 2011 Jul;65(3-4):532-43. doi: 10.1007/s11418-011-0535-9. Epub 2011 Apr 11. https://pubmed.ncbi.nlm.nih.gov/21479964/

4 Mol. Nutr. Food Res. 2013, 57, 1529–1542 https://sci-hubtw.hkvisa.net/https://doi.org/10.1002/mnfr.201200838

5 Mol Cell Biochem. 2021 Jun 9 : 1–30. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8187459/

6 Signal Transduct Target Ther. 2017; 2: 17023.

7 Stem Cell Res Ther. 2014 ;5(4):100. Epub 2014 Sep 26. PMID: 25928248

8 Nutr Cancer. 2006;55(2):126-31.

9 Acta Pharm. 2016 Sep 1;66(3):387-98. doi: 10.1515/acph-2016-0028. https://pubmed.ncbi.nlm.nih.gov/27383887/

10 Mol. Nutr. Food Res. 2013, 57, 1529–1542 https://sci-hubtw.hkvisa.net/https://doi.org/10.1002/mnfr.201200838

11 Toxicon October 1992, Volume 30, Issue 10, Pages 1211-1218 https://www.sciencedirect.com/science/article/abs/pii/004101019290437A

12 Mol. Nutr. Food Res. 2013, 57, 1529–1542 https://sci-hubtw.hkvisa.net/https://doi.org/10.1002/mnfr.201200838

13 Scientific Reports volume 9, Article number: 8145 (2019) https://www.nature.com/articles/s41598-019-44677-3

14 Mol. Nutr. Food Res. 2013, 57, 1529–1542 https://sci-hubtw.hkvisa.net/https://doi.org/10.1002/mnfr.201200838

15 Stem Cell Research & Therapy September 26, 2014 https://stemcellres.biomedcentral.com/articles/10.1186/scrt500

16 Science Daily September 25, 2014 https://www.sciencedaily.com/releases/2014/09/140925205819.htm

17 Stem Cell Research & Therapy September 26, 2014 https://stemcellres.biomedcentral.com/articles/10.1186/scrt500

18 Stem Cell Research & Therapy September 26, 2014 https://stemcellres.biomedcentral.com/articles/10.1186/scrt500

19 Stem Cell Res Ther. 2014; 5(6): 127. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4339474/

20 Science Daily September 25, 2014 https://www.sciencedaily.com/releases/2014/09/140925205819.htm

21 Small. 2010 Nov 22; 6(22): 2509–2513. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2991395/

22 Science Daily September 25, 2014 https://www.sciencedaily.com/releases/2014/09/140925205819.htm

23 Int J Biochem Cell Biol. 2005 May;37(5):942-6. doi: 10.1016/j.biocel.2004.09.009. Epub 2004 Dec 2. https://pubmed.ncbi.nlm.nih.gov/15743669/

24 Cells 2021, 10(5), 1090; https://doi.org/10.3390/cells10051090 https://www.mdpi.com/2073-4409/10/5/1090/htm

25 Front. Neurol., 20 March 2019 https://www.frontiersin.org/articles/10.3389/fneur.2019.00271/full

26 Cells 2021, 10(5), 1090; https://doi.org/10.3390/cells10051090 https://www.mdpi.com/2073-4409/10/5/1090/htm

27 Science Daily July 14, 2021 https://www.sciencedaily.com/releases/2021/07/210714110452.htm

28 Mol Nutr Food Res. 2018 Jan;62(2). doi: 10.1002/mnfr.201700281. Epub 2018 Jan 8. https://pubmed.ncbi.nlm.nih.gov/28849618/

29 NeuroReport: December 16, 2020 - Volume 31 - Issue 18 - p 1302-1307 https://journals.lww.com/neuroreport/Abstract/2020/12020/Neuroprotective_effects_of_aromatic_turmerone_on.3.aspx

30 BMC Complement Altern Med. 2013; 13: 299. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3840684/

31 Synchro

32 Int J Mol Sci. 2016 Nov; 17(11): 1895. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5133894/

33 Science. 2014 Oct 17; 346(6207): 298–299. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4261922/

34 Scientific Reports volume 7, Article number: 814 (2017) https://www.nature.com/articles/s41598-017-00812-6

35 BioFactors, Synergistic Chemoprevention by Turmeric Components https://iubmb.onlinelibrary.wiley.com/doi/epdf/10.1002/biof.1054

36 PLoS One. 2013; 8(12): e81634. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3862488/

37 Z Naturforsch C J Biosci. Sep-Oct 2002;57(9-10):828-35. doi: 10.1515/znc-2002-9-1013. https://pubmed.ncbi.nlm.nih.gov/12440720/

38 Food Chem Toxicol. 2010 Aug–Sep; 48(8-9): 2011–2020. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2910176/

39 Z Naturforsch C. 2001 Jan-Feb;56(1-2):40-4. PMID: 11302211 https://www.greenmedinfo.com/article/turmeric-oil-exhibits-anti-fungal-activity

40 J Med Entomol. 2015 Sep;52(5):979-86. doi: 10.1093/jme/tjv072. Epub 2015 Jun 23. https://pubmed.ncbi.nlm.nih.gov/26336212/

41 Int J Dermatol. 2011 Sep ;50(9):1058-66. PMID: 22126865

42 Diabetol Metab Syndr. 2013 ;5(1):75. Epub 2013 Nov 26. PMID: 24279645

43 Neurosci Lett. 2015 Nov 10 ;610:139-143. Epub 2015 Nov 10. PMID: 26552010

44 J Med Assoc Thai. 2012 May ;95 Suppl 5:S133-41. PMID: 22934459

45 Nutr J. 2012; 11: 79. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3518252/

46 Mol Cell Biochem. 2021 Jun 9 : 1–30. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8187459/

47 Mol. Nutr. Food Res. 2013, 57, 1529–1542 https://sci-hubtw.hkvisa.net/https://doi.org/10.1002/mnfr.201200838

48 Mayo Clinic, Stem cells: What they are and what they do https://www.mayoclinic.org/tests-procedures/bone-marrow-transplant/in-depth/stem-cells/art-20048117

49 Phytotherapy Research August 4, 2019 doi:10.1002/ptr.6482 https://sci-hubtw.hkvisa.net/10.1002/ptr.6482

50 Phytotherapy Research August 4, 2019 doi:10.1002/ptr.6482 https://sci-hubtw.hkvisa.net/10.1002/ptr.6482

51 Phytotherapy Research August 4, 2019 doi:10.1002/ptr.6482 https://sci-hubtw.hkvisa.net/10.1002/ptr.6482

52 Phytotherapy Research August 4, 2019 doi:10.1002/ptr.6482 https://sci-hubtw.hkvisa.net/10.1002/ptr.6482

53 Mol Cell Biochem. 2021 Jun 9 : 1–30. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8187459/

54 Mol Cell Biochem. 2021 Jun 9 : 1–30. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8187459/

55 Mol Cell Biochem. 2021 Jun 9 : 1–30. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8187459/

56 Mol Cell Biochem. 2021 Jun 9 : 1–30. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8187459/

57 Mol Cell Biochem. 2021 Jun 9 : 1–30. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8187459/

58 Planta Med. 1998 May;64(4):353-6.

59 Journal of Complementary and Integrative Medicine June 25, 2016
https://www.degruyter.com/document/doi/10.1515/jcim-2016-0016/html

60 Int J Cancer. 2009 Oct 15; 125(8): 1992–1993. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2747637/

61 Mol. Nutr. Food Res. 2013, 57, 1529–1542 https://sci-hubtw.hkvisa.net/https://doi.org/10.1002/mnfr.201200838

62 J Med Food. 2012 Mar; 15(3): 242–252. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3282471/

63 Advances in Nutrition, Volume 9, Issue 1, January 2018, Pages 41–50, https://doi.org/10.1093/advances/nmx011
https://academic.oup.com/advances/article/9/1/41/4848948

64 Epicurious, Golden Milk https://www.epicurious.com/recipes/food/views/golden-milk-turmeric-tea