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Health Implications of Capsaicin: Weighing the Benefits and Risks of Spicy Foods - a review of the literature

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ABSTRACT

Capsaicin is very well known as the principal active constituent in chili peppers, however, despite widespread recognition of this substance as a simple enhancer of spicy flavour, it is also a complicated agent that exerts its effects on human health. This review discusses the bifold potency of capsaicin, signifying its strong therapeutic potential and concomitant risks. By interaction with TRPV1 receptors, capsaicin provides analgesic and anti-inflammatory effects, which makes it exceptionally suitable for managing chronic pain, inflammation, or neuropathy. It also has been proven neuroprotective, cognitively improving, and possibly effective in degenerative disorders such as Alzheimer's or Parkinson's disease. In addition to all of that, Capsaicin has also a noticeable influence on the cardiovascular system and metabolic regulation, by improving lipid profiles, and endothelial function. Its anticancer activity through apoptosis promotion and inhibition of angiogenesis emphasizes its therapeutic versatility. However, some side effects depending on dosage have also been proven, making it mandatory to take it into consider it when choosing the appropriate amount of the dose. Excessive intake can irritate the gastrointestinal tract and further aggravate reflux symptoms, as well as damage to the esophageal endothelial barrier. In addition, in some cases, it has been associated with vasoconstriction due to high intake, which might be concerning for patients suffering from cardiovascular diseases. Studies also link it with increased abdominal obesity, hyperlipidemia, and hyperuricemia.

Keywords: Capsaicin, TRPV1 Receptors, pain relief, cancer prevention, metabolic health, cardiovascular effects

1. INTRODUCTION

Objective of the Study

This review will look into the dual-edged nature of capsaicin as an example of potent bioactive compounds found in hot foods by critically examining their health benefits and risks as reported in modern scientific literature (Wang et al., 2023; Kwon, 2021). It aimes to provide a balanced overview of the physiological as well as the molecular and therapeutic implications in clinical practice and dietary recommendations (Chen et al., 2017; Zhang et al., 2024).

Importance of the Topic

Capsaicin consumption has surged globally due to its incorporation into culinary traditions and potential health benefits (Yi et al., 2016; Kwon, 2021). Even though studies underline its anti-inflammatory, metabolic, and even anticancer properties, there remains a criticism regarding potential adverse effects on the gastrointestinal and cardiovascular systems, especially among patients suffering from chronic diseases (Yi et al., 2016; Dong et al., 2021). Sophisticated understanding of those effects is imperative for providing treatment properly beneficial and safe for the patient (Dong et al., 2021; Luo et al., 2022).

Characteristics of Capsaicin

Capsaicin is a lipophilic alkaloid primarily responsible for the pungency of chili peppers (Zhang et al., 2024). It engages sensory, neural, and inflammatory pathways, making it a compound of interest in pharmacology and nutrition (Dong et al., 2021; Petran et al., 2024). Its unique ability to activate and desensitize specific receptors distinguishes it from other bioactive food components (Petran et al., 2024; Das et al., 2023). Capsaicin (8-methyl-N-vanillyl-6-nonenamide) belongs to the capsaicinoid family and exerts potent sensory effects by targeting pain receptors (Kwon, 2021; Petran et al., 2024). Beyond its spicy profile, capsaicin holds promise as a therapeutic agent for managing chronic pain, obesity, and inflammatory conditions (Chen et al., 2017; Zhang et al., 2024).

Sources of Capsaicin in the Diet

Capsaicin-rich foods, including chili peppers and their derivatives (e.g., sauces and powders), are staples in many cuisines worldwide (Kwon, 2021; Yi et al., 2016). Regional variations in chili pepper cultivation influence the capsaicinoid content, with Capsicum annuum and Capsicum frutescens being primary dietary sources (Chen et al., 2017; Kwon, 2021).

Mechanism of Action of Capsaicin

Capsaicin exerts its effects through activation of the transient potential vanilloid 1 (TRPV1) receptor, a non-selective cation channel expressed on sensory neurons (Yi et al., 2016; Petran et al., 2024). Its interaction with TRPV1 leads to sensations of heat and burning, initiating neural and systemic responses contributing to its diverse biological effects (Kwon, 2021; Dong et al., 2021).

Cellular and Molecular Mechanisms

At the cellular level, capsaicin modulates calcium influx, reactive oxygen species (ROS) production, and inflammatory pathways (Zhang et al., 2024; Petran et al., 2024). These effects underlie its reported benefits in reducing oxidative stress, improving lipid profiles, and suppressing tumorigenic pathways (Yi et al., 2016; Dong et al., 2021). Nevertheless, the risk of potential damage from the compound to epithelial barriers and aggravation of oxidative damage requires further observation (Kwon, 2021; Dong et al., 2021).

Role of the TRPV1 Receptor

The TRPV1 receptor is the principal mediator of capsaicin's physiological effects (Zhang et al., 2024). Besides the perception of pain, activation of TRPV1 has been linked to metabolism regulation, thermogenesis, and inflammation (Kwon, 2021; Dong et al., 2021). However, its dysregulation is related to hypersensitivity of the gastrointestinal tract and cardiovascular diseases, thus adding to the complexity of the receptor’s role in human health (Dong et al., 2021; Petran et al., 2024). This review seeks to examine the pharmacologic activity of capsaicin while exploring its possibility to cause side effects, and thereby discuss the inflections that apply to its clinical and dietary-use implications (Chen et al., 2017; Petran et al., 2024).

2. METHODOLOGY

By systematic review, we refer to the assessment of current scientific literature on the health benefits and risks associated with capsaicin. An extensive search through several medical databases like PubMed, EMBASE, and Scopus yielded relevant peer-reviewed studies for the systematic review. Literature was sourced from the aforementioned databases, covering publications from January 2000 to June 2024. The search strategy incorporated keywords such as "capsaicin", "TRPV1 receptors", "pain relief", "cancer prevention", "metabolic health" and "cardiovascular effects". Additional articles were sourced from reference lists of the selected publications to ensure a proper insight into the subject. Only studies published in English were included in the inclusion criteria, focusing on human trials, animal experiments, and in vitro research, relating to the pharmacological actions, therapeutic applications, and possible side effects of capsaicin.

Investigations excluded lack of relevance, purely unrelated, or non-conclusive studies. The review examined publications spanning diverse medical disciplines, including neurology, oncology, gastroenterology, cardiology, and metabolic research. Data extraction focused on mechanisms of action, clinical outcomes, and safety profiles of capsaicin. Neuroprotection, pain management, cardiovascular health, metabolic effects, and possible risks were main factors, in terms of categories in which the results were organized. This methodical framework made the synthesis of evidence balanced and comprehensive with a nuanced exploration of the benefits and challenges of capsaicin. Establishment of existing gaps in knowledge was intended to inform the future design of research and related clinical application.

3. RESULTS AND DISCUSSION

Neuroprotection and Cognitive Benefits

There has been considerable interest in the prospects of capsaicin for the nervous system, such as neuroprotection, activity against neurodegenerative diseases, for example, Alzheimer's and Parkinson's, as well as cognitive enhancement. Emerging research increasingly indicates that it is capable of affecting a variety of cellular and molecular pathways that are important for general neural integrity and well-being. This chapter is based on the different multidimensional benefits of capsaicin, concerning its activity in neuroprotective properties, as well as in aiding neurodegenerative diseases and its role in cognitive function enhancement. In Alzheimer's disease (AD), capsaicin reduces neurodegeneration and memory impairment.

Studies have shown that capsaicin activates TRPV1 receptors, which help reduce the accumulation of toxic amyloid plaques in the brain, characteristic of AD. Capsaicin also enhances the brain's ability to clear these plaques, improving cognitive function (Pasierski and Szulczyk, 2022; Abdel-Salam and Mózsik, 2023). During trials performed among the participants from China, increased intake of spicy food was associated with improved performance on cognitive tests and favorable biomarkers related to AD (Tian et al., 2020). These findings suggest that a capsaicin-rich diet may offer protect effects against cognitive decline in AD. Additionally, capsaicin has been found to reduce inflammation and oxidative stress, critical factors in the progression of AD (Pasierski and Szulczyk, 2022). Capsaicin has also shown promise in the treatment of Parkinson's disease (PD).

In animal models, capsaicin administration has been found to reduce neurodegeneration and motor impairment. The neuroprotective effects of capsaicin in PD are primarily mediated through the activation of TRPV1 receptors, which decrease microglial activation and reduce neuroinflammation. Capsaicin treatment is known to increase the number of dopaminergic neurons in the substantia nigra and improve dopamine levels in the striatum, thereby improving motor function, which is critically deficient in Parkinsonism because of the general dopamine deficiency associated with the disease (Pasierski and Szulczyk, 2022; Abdel-Salam and Mózsik, 2023). Capsaicin's impact on cognitive functions extends beyond neurodegenerative diseases.

In animal studies, capsaicin has been shown to improve spatial learning and memory by enhancing hippocampal synaptic function and increasing the expression of neuroprotective proteins such as postsynaptic density protein 95 (PSD95) (Thornton et al., 2023). Capsaicin also reduces oxidative stress and inflammation, which are critical factors in maintaining cerebrovascular health and cognitive function. In humans, a study involving community-dwelling adults in China found that a capsaicin-rich diet was positively correlated with higher Mini-Mental State Examination (MMSE) scores, indicating better cognitive performance (Thornton et al., 2023; Chen et al., 2023). Capsaicin is implicated in improving endothelial function and the mobilization of nitric oxide as part of its role in enhancing cerebrovascular health and cognitive function (Thornton et al., 2023).

Potential benefits concerning epilepsy and stroke have also been highlighted with the use of capsaicin. Research has shown that in the animal models of epilepsy, capsaicin can reduce the frequency and severity of seizures. This effect is thought to be mediated through the modulation of TRPV1 receptors, which play a role in neuronal excitability and synaptic transmission (Abdel-Salam and Mózsik, 2023; Yang and Zheng, 2017). It has also been reported that capsaicin has protective effects in models of ischaemic stroke. Capsaicin activates TRPV1 receptors, causing reductions in infarct size, lowering neuronal apoptosis, and improving functional recovery from stroke (Abdel-Salam and Mózsik, 2023).

Overall, capsaicin has shown promising neuroprotective effects in both animal and human studies. It has been found to reduce neurodegeneration and improve cognitive functions in Alzheimer's and Parkinson's diseases. In addition to that, capsaicin's capacity to enhance cerebrovascular health, mitigate inflammation and oxidative stress, and possibly improve conditions such as epilepsy and stroke, all serve to confirm its promise as a possible therapeutic agent in cognitive health. It has been argued that more research into human study is needed, but available evidence suggests that a diet rich in capsaicin is good for the nervous system.

Analgesic and Anti-inflammatory Effects

Capsaicin, the bioactive compound responsible for the spiciness of foods, has been extensively studied for its analgesic and anti-inflammatory properties. This makes it a highly important therapeutic agent for the treatment of a variety of neuropathies, such as diabetic neuropathy and postherpetic neuralgia, as well as in inflammatory conditions. Regarding pain alleviation, capsaicin acts through TRPV1 receptors, which have a marked function in perceptions of pain. When capsaicin binds to these receptors, it causes an influx of calcium and sodium ions into nerve cells, leading to their activation. Initially, this may cause sensations of warmth, burning, stinging, or itching, but prolonged exposure to capsaicin results in the "defunctionalization" of nerve fibers, leading to reduced skin sensitivity and relieve pain (Frias and Merighi, 2016; Anand and Bley, 2011).

Consuming spicy foods containing capsaicin can help manage neuropathic pain, such as diabetic peripheral neuropathy, postherpetic neuralgia, and chemotherapy-induced peripheral neuropathy. In the treatment of neuropathic pain, capsaicin has also found use in the form of a high-concentration 8% patch (Qutenza™). Studies have shown that a single 60-minute application of this patch can provide pain relief for up to 12 weeks (Anand and Bley, 2011; Bonezzi et al., 2020). Notably, capsaicin creams have shown benefits in reducing pain in patients with diabetic neuropathy (Dludla et al., 2022). Capsaicin provides effective durable pain relief and reduction of intensity and area of pain in adult patients with chronic pain with a faster onset of analgesia and considerably fewer systemic adverse effects than the conventional treatment (Gašparini et al., 2020).

Capsaicin consumption can also offer benefits in the context of inflammatory conditions. Capsaicin modulates the release of neuropeptides and cytokines involved in inflammatory processes. Activation of TRPV1 on sensory nerve endings leads to the release of substance P, calcitonin gene-related peptide (CGRP), and other neuropeptides that contribute to neurogenic inflammation. However, prolonged exposure to capsaicin depletes these neuropeptides, reducing inflammation (Frias and Merighi, 2016; Arora et al., 2021). Experimental studies demonstrate that capsaicin can reduce inflammation in various tissues, including the gastrointestinal tract, respiratory system, and bladder. For instance, in models of gastrointestinal inflammation, capsaicin reduces levels of pro-inflammatory cytokines and tissue damage.

Likewise, capsaicin may relieve airway inflammation in respiratory conditions such as asthma, reducing the release of inflammatory mediators by sensory nerves (Frias and Merighi, 2016). Summarised, capsaicin is a very effective agent in the alleviation of neuropathic pain as well as in reducing inflammatory states. It has appreciated therapeutic value, mainly because it has this unique quality of interference at the TRPV1 receptors and can induce modulation in the release of neuropeptides and cytokines. Possessing bright anticipations, the properties of capsaicin hold a broad potential scope in the improving of the quality of life for chronic pain and inflammation patients, along with further research, which can very well elucidate mechanisms and broaden the scope of therapeutic applications.

Benefits for Other Systems

Capsaicin-the active constituent of hot chilies - is persuasive in tempering numerous different advantages, such as its well-known analgesic and anti-inflammatory actions. Emerging insights on cancer and cardiovascular health indicate the possible role of these findings in their respective prevention, but leave the evidence mixed, while reporting both advantages and disadvantages (Yi et al., 2016; Zhang et al., 2024). This chapter expands on the effects of capsaicin on human health, especially anticancer effects and the impact on cardiovascular systems.

Anticancer Activity

Capsaicin exhibits an interesting anticancer potential in different preclinical studies in terms of various pathways related to tumor formation and development (Petran et al., 2024; Brown et al., 2023; Merritt et al., 2022). It targets cancer cells by promoting apoptosis, inhibiting angiogenesis, and modulating cell cycle regulators (Kwon, 2021; Zhang et al., 2024). Capsaicin interacts with intracellular pathways to increase oxidative stress and disrupt mitochondrial function, selectively damaging malignant cells while sparing normal ones (Chen et al., 2017; Petran et al., 2024). In gastric and colorectal cancers, capsaicin suppresses tumor growth by modulating inflammatory cytokines and reducing cellular proliferation (Kwon, 2021; Dong et al., 2021).

Similarly, in breast and prostate cancer models, capsaicin has shown efficacy in downregulating proteins that promote metastasis and survival (Zhang et al., 2024; Petran et al., 2024). Nevertheless, contradictory evidence indicates that the effects of capsaicin might be dose - dependent, tumor type dependent, and genetically dependent (Chen et al., 2017; Yi et al., 2016). Potentially, high doses or sustained contact may aggravate some risks of developing cancer; hence, a requirement for rigorously controlled human studies to ascertain the safety and therapeutic benefits (Petran et al., 2024; Dong et al., 2021).

Cardiovascular Health

Cardiovascular health can be affected by capsaicin in a multiplicity of ways (Table 1). On the one hand, indicates cardioprotective attributes, specifically in regulating blood pressure, lipid metabolism, and vascular health (Petran et al., 2024). Capsaicin activates TRPV1 receptors in endothelial cells, stimulating nitric oxide release, thereby opening blood vessels and improving circulation (Yi et al., 2016; Petran et al., 2024; Deng et al., 2023). In studies involving hypertensive models, capsaicin reduced systolic and diastolic blood pressure, likely through improved endothelial function and enhanced vasodilation (Dong et al., 2021; Szallasi, 2022). Capsaicin also plays a role in metabolic health by improving lipid profiles and reducing inflammation, which are critical for cardiovascular disease prevention (Chen et al., 2017; Zhang et al., 2024).

It lowers levels of low-density lipoprotein (LDL) cholesterol and triglycerides while promoting high-density lipoprotein (HDL) cholesterol, contributing to a healthier lipid balance (Yi et al., 2016; Kwon, 2021). Despite these benefits, capsaicin is not without potential cardiovascular risks. Some studies report that excessive or chronic consumption may lead to vasoconstriction in sure vascular beds, reducing blood flow and potentially worsening ischemic conditions (Yi et al., 2016; Zhang et al., 2024; Ng et al., 2024). These adverse effects appear dose-dependent and are more likely in individuals with pre-existing cardiovascular conditions (Dong et al., 2021). In this sense, doctors must balance the risks and merits of capsaicin-rich diets for patients with cardiovascular disorders (Kwon, 2021; Chen et al., 2017).

Capsaicin's benefits extend across multiple systems, with notable anticancer activity and cardiovascular effects (Chen et al., 2017; Petran et al., 2024). Capsaicin offers a promising therapeutic efficacy inducing apoptosis in neoplastic cells, improving lipid metabolism and the state of the vasculature (Yi et al., 2016; Zhang et al., 2024). However, the dual-edged nature of it, especially the chance of causing adverse effects in high dosages or susceptible populations, calls for further research (Kwon, 2021; Zhang et al., 2024). It is becoming increasingly clear that capsaicin may also have a broader application in prevention and treatment because of the systemic effects that have been uncovered about it (Chen et al., 2017; Petran et al., 2024).

Table 1 Capsaicin's Health Benefits Across Biological Systems

System	Key Benefits	Mechanism of Action
Nervous System	Neuroprotection, reduced neurodegeneration, enhanced cognitive function, reduced inflammation	Activation of TRPV1, reduction of amyloid plaques, dopamine regulation, anti-inflammatory effects
Pain and Inflammation	Alleviation of neuropathic pain, reduced chronic inflammation	TRPV1 receptor modulation, neuropeptide depletion
Cardiovascular	Improved endothelial function, lipid profile	TRPV1 activation, nitric oxide release, lipid

System	enhancement, blood pressure regulation	metabolism improvement
Cancer Prevention	Induced apoptosis, inhibition of angiogenesis, reduced tumor growth	Oxidative stress induction, modulation of cell cycle regulators

Risks and Side Effects of Capsaicin Consumption

While capsaicin offers numerous health benefits, its consumption is not without risks. Studies indicate that high or chronic intake may pose challenges to several bodily systems, including the digestive and cardiovascular systems, and may contribute to obesity and metabolic disorders. This chapter examines the potential adverse effects of capsaicin, providing a nuanced perspective on its risks and benefits.

Digestive System

Capsaicin consumption may irritate the gastrointestinal (GI) tract, especially in individuals predisposed to conditions like gastritis or irritable bowel syndrome (Chen et al., 2017; Chan et al., 2021; Cheng et al., 2023; Zhang et al., 2024). High doses can damage the epithelial lining, leading to symptoms such as abdominal pain, nausea, and diarrhea (Kwon, 2021). While capsaicin shows potential anticancer effects, some studies suggest it could increase cancer metastasis under certain conditions, possibly by enhancing angiogenesis and inflammatory signaling pathways (Petran et al., 2024; Yi et al., 2016). These effects underscore the need for careful dosing, particularly in populations with pre-existing GI conditions or malignancies.

Cardiovascular System

Capsaicin's interaction with cardiovascular health presents both risks and benefits. While it enhances vasodilation and improves endothelial function, high consumption may paradoxically lead to vasoconstriction in some vascular beds, exacerbating conditions like hypertension and ischemic heart disease (Yi et al., 2016; Kwon, 2021; Munjuluri et al., 2021; Mathew et al., 2021). Individuals who already suffer from cardiovascular disease (CVD) may be even more susceptible to these unfavorable consequences, emphasizing personalized dietary recommendations in such a case (Dong et al., 2021).

Obesity and Metabolic Disorders

Capsaicin's role in metabolic health remains controversial (Li et al., 2024). While it may aid weight management, excessive consumption has been linked to abdominal obesity and hyperlipidemia in specific populations (Yi et al., 2016; Petran et al., 2024; Yang et al., 2022). Capsaicin modulates lipid profiles unfavorably in individuals with predisposing factors, increasing triglyceride levels and contributing to metabolic imbalances (Kwon, 2021; Dong et al., 2021). Additionally, its impact on uric acid levels poses a risk for hyperuricemia, a condition associated with gout and kidney dysfunction (Chen et al., 2017; Zhang et al., 2024).

Cancer

The relationship between capsaicin and cancer risk is complex and dose-dependent. While it has demonstrated protective effects against gastrointestinal cancers by reducing inflammation and oxidative stress, high doses may increase the risk of certain cancers, including esophageal and gastric (Yi et al., 2016; Petran et al., 2024). Capsaicin's potential to promote tumorigenesis appears to depend on its interaction with specific cellular pathways, particularly in chronic inflammation or high dietary intake (Kwon, 2021). Thus, moderation is key to harnessing its anticancer properties without increasing risk.

Reflux and Dyspepsia

Capsaicin can exacerbate symptoms of reflux and dyspepsia, particularly in individuals with gastroesophageal reflux disease (GERD). By stimulating TRPV1 receptors in the esophagus, capsaicin may intensify sensations of heartburn and discomfort (Chen et al., 2017; Rodriguez-Stanley et al., 2000; Xiang et al., 2022; Petran et al., 2024). Chronic exposure could also impair the esophageal mucosal barrier, compounding symptoms of acid reflux and dyspepsia (Yi et al., 2016; Zhang et al., 2024).

4. CONCLUSION

Capsaicin, the primary bioactive compound in chili peppers, holds great potential in numerous domains of health and medicine. Its effects at TRPV1 receptors for modulation of pain, its anti-inflammatory activity, and its modulation of metabolic and cardiovascular health render it a potential therapeutic agent. In addition, potential neuroprotective effects, anticancer activity, and cognitive-enhancing capabilities have made it the center of increasing scientific interest. Nevertheless, although Capsaicin's positive impact on health has been proven in plenty of cases, its activity isn't always beneficial. The effects of the compound are highly dose-dependent and differ from individual health status, genetic predispositions, or existing medical conditions.

Some of the dangers of consumption in high or chronic amounts include irritability of the gastrointestinal system, aggravation of reflux symptoms, potentially causing vasospasm, and in particular contexts, cancer metastases. These initiated findings highlight the fundamental importance of moderation in terms of individualized dietary plans. This is particularly important for those individuals who have had pre-existing conditions. The two-sided nature of capsaicin is the reason for the need to extend studies on this subject. Reinvestigation is necessary to establish external, long-term safety profiles, optimal doses given, and suitable indications and applications in diseases such as Alzheimer's disease, as well as in chronic pain and cancer.

A greater understanding of the mechanisms and effects of capsaicin will allow us to maximize its beneficial therapeutic potential and minimize possible risks. Capsaicin is an excellent example of how nature and human beings can be closely intertwined about, concerning health. The safest way by which the benefits of introducing it into medicine and dietary practices could be maximized would be to do so by sound evidence and to cater to the needs of the individual. As research advances, capsaicin may play an increasingly significant role in preventive and therapeutic strategies across multiple domains of medicine.

Authors' Contribution

Michalina Doligalska: Conceptualization, writing- rough preparation, investigation,
Daniel Zieliński: Formal analysis, supervision
Aleksandra Stremel: Visualization, data curation
Emilia Bachoń: Conceptualization, data curation
Wiktoria Wesołowska: Methodology, project administration
Agnieszka Leszyńska: Conceptualization, methodology,
Aleksandra Jonkisz: Resources, writing- rough preparation
Małgorzata Sędek: Conceptualization, writing- rough preparation
Weronika Tuszyńska: Resources, data curation
Anna Weigle: Writing - Review and editing, supervision
All authors have read and agreed to the published version of the manuscript.

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Informed consent

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

REFERENCES

1. Abdel-Salam OME, Mózsik G. Capsaicin, The Vanilloid Receptor TRPV1 Agonist in Neuroprotection: Mechanisms Involved and Significance. Neurochem Res 2023; 48(11):3296-3315. doi: 10.1007/s11064-023-03983-z
2. Anand P, Bley K. Topical capsaicin for pain management: therapeutic potential and mechanisms of action of the new high-concentration capsaicin 8% patch. Br J Anaesth 2011; 107(4):490-502. doi: 10.1093/bja/aer260
3. Arora V, Campbell JN, Chung MK. Fight fire with fire: Neurobiology of capsaicin-induced analgesia for chronic pain. Pharmacol Ther 2021; 220:107743. doi: 10.1016/j.pharmthera.2020.107743
4. Bonezzi C, Costantini A, Cruccu G, Fornasari DMM, Guardamagna V, Palmieri V, Polati E, Zini P, Dickenson AH. Capsaicin 8% dermal patch in clinical practice: an expert opinion. Expert Opin Pharmacother 2020; 21(11):1377-1387. doi: 10.1080/14656566.2020.1759550
5. Brown KC, Modi KJ, Light RS, Cox AJ, Long TE, Gadepalli RS, Rimoldi JM, Miles SL, Rankin G, Valentovic M, Denning KL, Tirona MT, Finch PT, Hess JA, Dasgupta P. Anticancer Activity of Region B Capsaicin Analogs. J Med Chem 2023; 66(7):4294-4323. doi: 10.1021/acs.jmedchem.2c01594
6. Chan WC, Millwood IY, Kartsonaki C, Du H, Guo Y, Chen Y, Bian Z, Walters RG, Lv J, He P, Hu C, Li L, Yang L, Chen Z; China Kadoorie Biobank (CKB) Collaborative Group. Spicy food consumption and risk of gastrointestinal-tract cancers: findings from the China Kadoorie Biobank. Int J Epidemiol 2021; 50(1):199-211. doi: 10.1093/ije/dyaa275
7. Chen L, Ding R, Luo Q, Tang X, Ding X, Yang X, Liu X, Li Z, Xu J, Meng J, Gao X, Tang W, Wu J. Association between spicy food and hypertension among Han Chinese aged 30-79 years in Sichuan Basin: a population-based cross-sectional study. BMC Public Health 2023; 23(1):1663. doi: 10.1186/s12889-023-16588-6
8. Chen YH, Zou XN, Zheng TZ, Zhou Q, Qiu H, Chen YL, He M, Du J, Lei HK, Zhao P. High Spicy Food Intake and Risk of Cancer: A Meta-analysis of Case-control Studies. Chin Med J (Engl) 2017; 130(18):2241-2250. doi: 10.4103/0366-6999.213968
9. Cheng P, Wu J, Zong G, Wang F, Deng R, Tao R, Qian C, Shan Y, Wang A, Zhao Y, Wei Z, Lu Y. Capsaicin shapes gut microbiota and pre-metastatic niche to facilitate cancer metastasis to liver. Pharmacol Res 2023; 188:106643. doi: 10.1016/j.phrs.2022.106643
10. Das S, Ray BK, Pandit A, Ghosh R, Diehl R, Dubey S, Kraemer M. Profile of precipitating factors and its implication in 160 Indian patients with Moyamoya angiopathy. J Neurol 2023; 270(3):1654-1661. doi: 10.1007/s00415-022-11499-9
11. Deng R, Yu S, Ruan X, Liu H, Zong G, Cheng P, Tao R, Chen W, Wang A, Zhao Y, Wei Z, Lu Y. Capsaicin orchestrates metastasis in gastric cancer via modulating expression of TRPV1 channels and driving gut microbiota disorder. Cell Commun Signal 2023; 21(1):364. doi: 10.1186/s12964-023-01265-3
12. Dludla PV, Nkambule BB, Cirilli I, Marcheggiani F, Mabhida SE, Ziqubu K, Ntamo Y, Jack B, Nyambuya TM, Hanser S, Mazibuko-Mbeje SE. Capsaicin, its clinical significance in patients with painful diabetic neuropathy. Biomed Pharmacother 2022; 153:113439. doi: 10.1016/j.biopha.2022.113439
13. Dong X, Li Y, Yang K, Zhang L, Xue Y, Yu S, Liu X, Tu R, Qiao D, Luo Z, Liu X, Wang Y, Li W, Wang C. Associations of spicy food flavour and intake frequency with blood lipid levels and risk of abnormal serum lipid levels in Chinese rural population: a cross-sectional study. Public Health Nutr 2021; 24(18):6201-6210. doi: 10.1017/S1368980021001853
14. Frias B, Merighi A. Capsaicin, Nociception and Pain. Molecules 2016; 21(6):797. doi: 10.3390/molecules21060797
15. Gašparini D, Ljubičić R, Mršić-Pelčić J. Capsaicin - Potential Solution for Chronic Pain Treatment. Psychiatr Danub 2020; 32(Suppl 4):420-428.
16. Kwon Y. Estimation of Dietary Capsaicinoid Exposure in Korea and Assessment of Its Health Effects. Nutrients 2021; 13(7):2461. doi: 10.3390/nu13072461
17. Li X, Li Y, Xiang B, Liu L, Zhang C, Li Z, Li D. Interaction of smoking and spicy habits modifies the risk of erectile dysfunction. Transl Androl Urol 2024; 13(7):1206-1218. doi: 10.21037/tau-24-26
18. Luo Q, Ding R, Chen L, Bu X, Xiao M, Liu X, Wu Y, Xu J, Tang W, Qiu J, Ding X, Tang X. The Association Between Spicy Food Intake and Risk of Hyperuricemia Among Chinese Adults. Front Public Health 2022; 10:919347. doi: 10.3389/fpubh.2022.919347

19. Mathew T, Souza DD, John SK, Sharath Kumar GG. Transient Ischemic Attack after Eating Spicy Foods in Children: Think of Moya Moya Disease. Neurol India 2021; 69(4):1032-1033. doi: 10.4103/0028-3886.325347
20. Merritt JC, Richbart SD, Moles EG, Cox AJ, Brown KC, Miles SL, Finch PT, Hess JA, Tirona MT, Valentovic MA, Dasgupta P. Anti-cancer activity of sustained release capsaicin formulations. Pharmacol Ther 2022; 238:108177. doi: 10.1016/j.pharmthera.2022.108177
21. Munjuluri S, Wilkerson DA, Sooch G, Chen X, White FA, Obukhov AG. Capsaicin and TRPV1 Channels in the Cardiovascular System: The Role of Inflammation. Cells 2021; 11(1):18. doi: 10.3390/cells11010018
22. Ng BW, Lee JS, Toh T. Spicy food induced transient ischemic attack: A diagnostic conundrum in a child with moyamoya vasculopathy. Pediatr Oncall J 2024. doi: 10.7199/ped.oncall.2025.63
23. Pasierski M, Szulczyk B. Beneficial Effects of Capsaicin in Disorders of the Central Nervous System. Molecules 2022; 27(8):2484. doi: 10.3390/molecules27082484
24. Petran EM, Periferakis A, Troumpata L, Periferakis AT, Scheau AE, Badarau IA, Periferakis K, Caruntu A, Savulescu-Fiedler I, Sima RM, Calina D, Constantin C, Neagu M, Caruntu C, Scheau C. Capsaicin: Emerging Pharmacological and Therapeutic Insights. Curr Issues Mol Biol 2024; 46(8):7895-7943. doi: 10.3390/cimb46080468
25. Rodriguez-Stanley S, Collings KL, Robinson M, Owen W, Miner PB Jr. The effects of capsaicin on reflux, gastric emptying and dyspepsia. Aliment Pharmacol Ther 2000; 14(1):129-34. doi: 10.1046/j.1365-2036.2000.00682.x
26. Szallasi A. Dietary Capsaicin: A Spicy Way to Improve Cardio-Metabolic Health? Biomolecules 2022; 12(12):1783. doi: 10.3390/biom12121783
27. Thornton T, Mills D, Bliss E. Capsaicin: A Potential Treatment to Improve Cerebrovascular Function and Cognition in Obesity and Ageing. Nutrients 2023; 15(6):1537. doi: 10.3390/nu15061537
28. Tian DY, Wang J, Sun BL, Wang Z, Xu W, Chen Y, Shen YY, Li HY, Chen DW, Zhou FY, Yi X, Zeng GH, Xu ZQ, Chen LY, Yu JT, Wang YJ. Spicy food consumption is associated with cognition and cerebrospinal fluid biomarkers of Alzheimer disease. Chin Med J (Engl) 2020; 134(2):173-177. doi: 10.1097/CM9.0000000000001318
29. Wang M, Huang W, Xu Y. Effects of spicy food consumption on overweight/obesity, hypertension and blood lipids in China: a meta-analysis of cross-sectional studies. Nutr J 2023; 22(1):29. doi: 10.1186/s12937-023-00857-6
30. Xiang Q, Tang X, Cui S, Zhang Q, Liu X, Zhao J, Zhang H, Mao B, Chen W. Capsaicin, the Spicy Ingredient of Chili Peppers: Effects on Gastrointestinal Tract and Composition of Gut Microbiota at Various Dosages. Foods 2022; 11(5):686. doi: 10.3390/foods11050686
31. Yang F, Zheng J. Understand spiciness: mechanism of TRPV1 channel activation by capsaicin. Protein Cell 2017; 8(3):169-177. doi: 10.1007/s13238-016-0353-7
32. Yang X, Tang W, Mao D, Liu X, Qian W, Dai Y, Chen L, Ding X. Spicy food consumption is associated with abdominal obesity among Chinese Han population aged 30-79 years in the Sichuan Basin: a population-based cross-sectional study. BMC Public Health 2022; 22(1):1881. doi: 10.1186/s12889-022-14293-4
33. Yi CH, Lei WY, Hung JS, Liu TT, Chen CL, Pace F. Influence of capsaicin infusion on secondary peristalsis in patients with gastroesophageal reflux disease. World J Gastroenterol 2016; 22(45):10045-10052. doi: 10.3748/wjg.v22.i45.10045
34. Zhang W, Zhang Y, Fan J, Feng Z, Song X. Pharmacological activity of capsaicin: Mechanisms and controversies (Review). Mol Med Rep 2024; 29(3):38. doi: 10.3892/mmr.2024.13162