INTERNATİONAL JOURNAL OF HEALTH & MEDİCAL RESEARCH

ISSN(print): 2833-213X, ISSN(online): 2833-2148

Volume 04 Issue 04 April 2025

DOI : 10.58806/ijhmr.2025.v4i4n06

Page No. 240-245

Okra Seed and Capsaicin in Light of Phytobiotic Approaches: Current Studies in Medicine and Dentistry

Mesut KAYĞUSUZ[1*], Mehmet Sinan DOĞAN[1]

Harran University Faculty of Dentistry Department of Pediatric Dentistry, Şanlıurfa, Türkiye

ABSTRACT: The therapeutic potential of natural biological agents has become more evident in modern medicine and dentistry with increasing scientific studies in recent years. In this review study, the pharmacological properties, biological effects and clinical applications of okra (Abelmoschus esculentus) seed extract, which is a phytotherapeutic agent, and capsaicin compound obtained from hot pepper were discussed. Okra seeds; Thanks to the phenolic compounds, flavonoids and polysaccharides it contains, it supports regeneration in oral tissues and contributes to the reduction of oxidative stress. At the same time, its anti-inflammatory, antimicrobial, hypoglycaemic properties have made it stand out as a promising natural agent in wound healing, glycaemic control and treatment of oral mucosal lesions. Capsaicin shows analgesic effect by affecting nerve conduction pathways via TRPV1 (Transient Receptor Potential Vanilloid 1) receptors. Studies have shown that capsaicin is effective in pulpal pain management and chronic orofacial pain. Both okra seeds and capsaicin show potential for use as antineoplastic agents in various malignancies, especially oral carcinomas, due to their effects on cell proliferation, apoptosis and angiogenesis. This review aims to present the interactions of these two natural compounds with oral biological systems, their contributions in medical and dental treatment processes, and their possible therapeutic roles, especially from the perspective of modern dentistry, in the light of current scientific data.

KEYWORDS; phytobiotic, phytotherapeutic, okra seed, capsaicin.

INTRODUCTION

1.Okra seed in medicine and its therapeutic effects

Okra (Abelmoschus esculentus (L.) Moench) is an annual herbaceous plant of the Malvaceae family. It is native to Northeast Africa, Ethiopia and Sudan, but is frequently cultivated in tropical and temperate hot regions of the world. It contains carbohydrates, proteins, fibres, thiamine, riboflavin, ascorbic acids and has economic and industrial values as well as being nutritious (Bereded Sheferie, 2023). Okra seed has come to the fore as a phytotherapeutic agent thanks to the flavonoids, terpenes, phenolic compounds and sterols contained in it. It shows many therapeutic effects including cardioprotective, antidiabetic, hypolipidaemic, antioxidant, antimicrobial, anti-inflammatory, anticancer, wound healing, hepatoprotective, immunomodulatory, neuroprotective and gastroprotective activities (Abdel-Razek, Abdelwahab, Abdelmohsen, & Hamed, 2023). Since okra seeds contain higher polyphenolic compounds than other okra parts, their antioxidant, antidiabetic and anti-inflammatory effects are more pronounced (Ong, Oh, Tan, Foo, & Leo, 2021).

1.1. Antimicrobial effects in okra seed

Antimicrobial effect of okra seed has been shown by studies. The aqueous extract of okra seed used in the study by Nie et al. was found to be effective against oral pathogens. In the antibacterial test, okra seed extract was found to be successful against Porphyromonas gingivalis and Streptococcus mutans. This showed that okra seed extract may be a good agent in periodontal diseases and prevention of dental caries (Nie, Liu, Xiao, Yari, & Goorani, 2023). Palmitic and stearic acids in okra seeds are effective against harmful bacteria such as Escherichia coli, Staphylococcus aureus, Rhodococcus opacus, Rhodococcus erythropolis, Mycobacterium aurum, Escherichia coli, Pseudomonas aeruginosa. These properties suggest that okra seeds can be used as natural antibiotics (Elkhalifa et al., 2021).

1.2. Antioxidant effects

Okra seeds derive their antioxidant activity from the large amounts of polyphenols and flavonoids contained in them. Polyphenols perform antioxidant activity by increasing the levels of superoxide dismutase and glutathione peroxidase. Quercetin in okra seeds also plays an important role in the antioxidant effect (Xia et al., 2015). Okra seeds are a rich source of phenols, including procyanidin B1 and B2, which eliminate free radicals (Khomsug, Thongjaroenbuangam, Pakdeenarong, Suttajit, & Chantiratikul, 2010).

1.3. Anticancer effects

Herbal products such as okra seeds have attracted the interest of many researchers worldwide due to their selective toxicity against malignant cells. The anticancer effect of okra seed extracts has been documented in vitro via cell line. The flavonoid isoquercitrin in seed extracts, in a synergistic relationship with other flavonoids, showed cytotoxic effects on cancer cell lines and eliminated cancerous cells by inhibiting vascular endothelial growth factor (VEGF) (Chaemsawang et al., 2019). Quercetin, an important flavonoid component of okra, blocks the Wnt/β-catenin signalling pathway. This has enabled it to show anticancer properties in cancer cells by creating an antiproliferative, antimigratory and antiinvasive environment resulting in apoptosis (Ping, 2020).

1.4. Gastroprotective effects

In an animal study investigating the protective effect of Abelmoschus esculentus seed oil on gastric ulcer, okra seed oil was proven to have a protective effect on gastric ulcer by reducing ulcer area, lowering total acidity and increasing pH value (Wei et al., 2017). Another study by Ortaç et al. reported that okra has a gastroprotective effect against ethanol and may be a potential antiulcer agent (Ortaç et al., 2018). Dietary okra seed oil plays an important role in alleviating alcohol-induced liver damage and intestinal microbiota dysbiosis. In a study in mice, dietary okra seed oil caused a decrease in Clostridium and Staphylococcus bacteria, while increasing the Bacteroidetes population. This shows that okra seed oil regulates intestinal flora (J. Zhang, Lu, Yang, & Zhao, 2019).

1.5. Cardioprotective effects

Hypertension has long-term adverse effects on the arteries and heart due to high blood pressure. Hypertension is responsible for 24% of coronary heart disease deaths worldwide and despite advances in medicine, 1.56 billion people are affected by hypertension today (Sinny, Ramesh, & Stephen, 2014). The systemic side effects and long-term resistance development of synthetic drugs used in the treatment of hypertension have led to an increased interest in plants, which are crude drugs with the compounds they contain. Okra seed, one of the phytotherapeutic plants, shows its cardioprotective properties with quercetin and flavonoids. Flavonoids increase vasodilatation by stimulating nitric oxide formation. Thus, it plays a critical role in preventing cardiovascular diseases by lowering blood pressure. Observing the contribution of daily diet in alleviating hypertension and examining the possible therapeutic activity of okra seeds, Mondal et al. proved the therapeutic efficacy of okra seeds in fructose-induced hypertensive rat models. It also improved heart rate and reduced total cholesterol and triglyceride levels in hypertensive rats (Mondal, Gowda, & Manandhar, 2019).

1.6. Antidiabetic effects

Diabetes mellitus is a heterogeneous metabolic disease characterised by high blood glucose levels. The lack of insulin activity in target tissues leads to abnormalities in glucose, lipid and protein metabolism. As a result, failure begins in many organs, especially kidneys, blood vessels, eyes, heart and nerves (Chaudhury et al., 2017). Today, non-pharmacological methods are frequently preferred in the treatment of diabetes, along with pharmacological methods. The fact that most pharmacological agents have serious side effects has led researchers to natural and herbal agents that are less toxic than drug treatments (Palsamy & Subramanian, 2008). Okra seed, one of the medicinal plants, shows its various antidiabetic effects thanks to the vitamins, polyphenolic compounds, polysaccharides and flavonoids contained in it. The study conducted by Aleissa et al. in rat models showed that okra peel and seed powder can strengthen the pancreas, kidney and liver due to its antioxidant effect in diabetic rats (Aleissa et al., 2022).

1.7. Hepatoprotective effects

In vivo and in vitro studies have shown that okra seeds reverse liver damage and contribute to the repair process in the livers of rats. Okra seeds show this function by decreasing alanine transaminase (ALT), aspartate transaminase (AST) and alkaline phosphatase (ALP) levels, decreasing total bilirubin level and increasing serum albumin (Saravanan, Pandikumar, Pazhanivel, Paulraj, & Ignacimuthu, 2013). At the same time, preventing triglyceride accumulation in the liver, decreasing TNF-α levels and improving liver histopathology are other hepatoprotective properties. Quercetin isolated from okra seeds is an important active compound for hepatoprotective effect. It prevents liver damage by eliminating reactive oxygen species with flavanoids and active compounds (Kwok, Ng, Chan, & Chan, 2025).

1.8. Wound healing effects of okra seed

The dried seeds of the plant are the most nutrient-dense part of the plant. The seed oil can be consumed and the waste meal from the oil extraction process is an excellent source of protein. The natural antioxidant and antistress activities of okra seed have made it even more popular (Doreddula et al., 2014). Vitamin C and vitamin E, which are the vitamins concentrated in okra seeds, contribute to wound healing (Adetuyi & Ibrahim, 2014).

1.9. Neuroprotective effects

Oxidative stress and psychological stress can cause the development of neurodegenerative diseases such as Alzheimer's disease. Studies have proved that okra seed is beneficial for neurodegenerative diseases. Sirtuin-1 is a protein and has an important role in cell repair. Okra seed shows neurodegenerative properties by reducing reactive oxygen and contributes to nerve regeneration by increasing the release of sirtuin-1 protein (Bakhsh et al., 2023). Excessive fluoride intake during pregnancy crosses the blood brain

barrier and causes adverse effects on neonatal development. The animal experiment study by Sudhakar et al. reported the protective effect of the seed extract against induced behavioural changes associated with neurochemical changes in the developing brains of rats (Sudhakar, Nageshwar, & Reddy, 2018).

2. OKRA SEED İN DENTİSTRY AND THERAPEUTİC EFFECTS

The fact that okra seeds contain bioactive compounds with antibacterial and wound healing properties has led to their potential use in dentistry. Okra seed shows a strong antibacterial effect against Streptococcus mutans bacteria. In their study, Kalarani et al. found that the antibacterial inhibition zones formed by okra extracts were equal to Ofloxacin, one of the commonly used antibiotics (Kalarani et al., 2017). In another study on Wistar rats, it was observed that the activity of fibroblast cells increased after application of the gel containing 30% okra extract to the alveolar extraction socket. The increase in fibroblasts indicates that the healing process after tooth extraction may accelerate (Luthfi et al., 2020). Another study found that okra extract increased vascular endothelial growth factor (VEGF) expression during the healing process after tooth extraction. This has shown that okra extract supports wound healing by increasing angiogenesis, especially in diabetic patients (Luthfi, Juliastuti, & Asyhari, 2019).

The lectin in okra seed has emerged as a phytotherapeutic of interest in dentistry due to its antinociceptive, anti-inflammatory and analgesic properties. Animal studies have shown that pretreatment with okra lectin significantly reduced inflammatory cell inflow in the synovial membrane in temporomandibular joint (TMJ) inflammation (Kwok et al., 2025). In rats, lectin treatment reduced mechanical hypernociception and decreased cytokine levels in TMJ tissue and trigeminal ganglion (Alves et al., 2018).

3. CAPSAİCİN İN MEDİCİNE AND İTS THERAPEUTİC EFFECTS

Capsicum annuum L., a chilli pepper belonging to the family Solanaceae, class Magnoliopsida, is an annual herb and is widely used in medicine. Its fruit is used in traditional medicines of some countries, especially China, to warm the body and promote digestion. This chilli contains several active ingredients, including capsaicin, the most abundant pungent compound, capsaicinoids and carotenoids (W. Zhang, Zhang, Fan, Feng, Feng, & Song, 2024).

Capsaicin, which gives hot peppers their characteristic pungent taste, is thought to be produced as a natural defence against herbivores and fungi. The effects of capsaicin on tissues have been under investigation for about a century. In the 1870s, burning sensation and hyperaemia were observed when applied to human skin. Capsaicin has become an interesting phacological agent with animal studies showing a decrease in blood pressure and an increase in saliva, gastric secretion and intestinal activity after intravenous injection of Capsicum extract (Sharma, Vij, & Sharma, 2013).

3.1. Analgesic effects of capsaicin

Capsaicin shows its analgesic properties by binding to the TRPV1 (transient receptor potential vanilloid 1) receptor in nerve cells, initiating first an activation and then a desensitisation process. Thanks to this effect, the transmission of pain signals is reduced and capsaicin acts as a powerful analgesic. In 1850, topical capsaicin was applied to burning and itching extremities and its analgesic properties were utilised. Creams and lotions containing capsaicin in the range of 0.025-0.1 wt% are now available in many countries, mostly without prescription, for the treatment of neuropathic and musculoskeletal pain (Anand & Bley, 2011). Neuropathic pain, a chronic type of pain, is caused by dysfunctions in the central and peripheral nervous system. The study by Yong et al. presented capsaicin as a promising treatment option, especially in neuropathic pain such as postherpetic neuralgia (Yong et al., 2017). In the animal model of Parkinson's disease by Shi et al., capsaicin reduced neuro-inflammation and oxidative stress by activating TRPV1 in M1/M2 dopaminergic neurons (Shi et al., 2019).

3.2. Antioxidant effects

High blood cholesterol levels increase oxidative stress by inhibiting antioxidant enzymes such as glutathione reductase, glutathione transferase and superoxide dismutase. Capsaicin provides antioxidant effect by reversing this situation (Kempaiah & Srinivasan, 2004). Studies have reported that capsaicin, which inhibits lipid peroxidation in red blood cells, liver and mitochondria of mice, shows antioxidant effect by inhibiting the peroxidation of low density lipoproteins in humans (Srinivasan, 2014).

3.3. Antitumour effects

Capsaicin shows antitumour activity in tumour cells by stopping the cell cycle and promoting apoptosis. Capsaicin exerts this effect in colon adenocarcinoma, pancreatic cancer, hepatocellular carcinoma, prostate cancer, breast cancer and many other cancer types without damaging normal cells (W. Zhang et al., 2024). Capsaicin is a hydrophobic, lipophilic vanilloid phytochemical abundant in chilli peppers. Several recent studies demonstrating the potent anticancer activity of capsaicin have reported that capsaicin suppresses the growth, angiogenesis and metastasis of various human cancers. By producing sustained-release formulations of capsaicin, it may show better solubility, stability, bioavailability and growth suppressive activity than the free drug. This will reduce the negative side effects of capsaicin (Merritt et al., 2022).

3.4. Cardioprotective effects

Myocardial infarction (MI) is one of the leading causes of death worldwide. Alhamd et al. drew attention to the cardioprotective activity of capsaicin and reported that capsaicin supplementation eliminates the adverse effects of isoproterenol and can be used as a new alternative cardiotherapy strategy in cardiac infarction (Abo Alhamd, Abdel EL-Hamid, Elsenosi, Marzouk, & Hanna, 2025). Capsaicin helps maintain vascular health by increasing nitric oxide production and reducing inflammatory responses. Capsaicin and vitamin C similarly exert beneficial effects on human endothelial cells by scavenging free radicals (Thongin et al., 2022).

4. OKRA SEED İN DENTİSTRY AND THERAPEUTİC EFFECTS

Capsaicin has been found to be successful in alleviating conditions such as oral neuropathic pain, trigeminal neuralgia, oral mucositis, temporomandibular joint disorders and burning mouth syndrome, and is a promising agent in inhibiting the proliferation of oral cancer cell lines (Yohana & Rafisa, 2024). Capsaicin inhibits alveolar bone resorption by inhibiting the growth of periodontitis-related pathogens, especially P. gingivalis (Zhou et al., 2014). In an animal study by Cong et al., it was observed that application of low dose topical capsaicin on the submandibular gland increased salivation. This was thought to be an important benefit in the control of microbial colonisation (Cong et al., 2012). Capsaicin shows antifungal properties, especially against Candida albicans, a common cause of oral candidiasis infections. Capsaicin disrupts C. albicans cell wall integrity by inhibiting ergosterol biosynthesis. Studies have also shown that the combination of capsaicin and fluconazole helps prevent fluconazole resistance (Behbehani, Irshad, Shreaz, & Karched, 2023). Burning Mouth Syndrome is a chronic neuropathic pain. The efficacy of capsaicin applications in different concentrations (0.01, 0.02, 0.025 and 0.25 per cent) and forms (capsule, gel and mouthwash) in Burning Mouth Syndrome has been investigated. In almost all of these studies, relief of pain and discomfort associated with the syndrome was found successful (Azzi et al., 2017). Capsaicin exhibits anti-inflammatory properties by reducing proinflammatory cytokines and vascular permeability. It does this by inhibiting prostaglandin E-2 and nitric oxide production (Kim et al., 2003). Capsaicin has the potential to inhibit the proliferation of certain viruses due to its ability to regulate immune and inflammatory responses. The therapeutic potential of capsaicin for viral infections in the oral cavity, especially Herpes Simplex virus, has been shown by studies (Hafiz, Mubaraki, Dkhil, & Al-Quraishy, 2017).

5. CONCLUSİON

In conclusion, capsaicin and Abelmoschus esculentus (okra) seed extract have remarkable therapeutic potential in medicine and dentistry due to their anti-inflammatory, antioxidant, analgesic and regenerative properties. Okra seed extract plays an important role in reducing oxidative stress and supporting cellular proliferation thanks to its rich polyphenol and flavonoid structures. Capsaicin, which modulates neurotransmission through TRPV1 receptors and suppresses inflammatory responses, becomes a valuable agent for pain control and pulpal tissue healing, especially in endodontic applications. Although animal models and in vitro studies support the biological efficacy of these natural compounds, more human-based, randomised and controlled studies are needed to confirm these findings at the clinical level. With appropriate pharmacological doses and controlled application protocols, natural agents such as capsaicin and okra seed are candidates to be part of biocompatible and innovative treatment approaches.

REFERENCES

1) Abdel-Razek, M. A., Abdelwahab, M. F., Abdelmohsen, U. R., & Hamed, A. N. (2023). A review: pharmacological activity and phytochemical profile of Abelmoschus esculentus (2010–2022). *RSC advances, 13*(22), 15280-15294.
2) Abo Alhamd, A. A., Abdel EL-Hamid, O. M., Elsenosi, Y. A., Marzouk, M. A., & Hanna, D. B. (2025). Ameliorative Effects of Capsaicin on Biochemical, Molecular, and Histopathological Changes in Experimentally-induced Cardiac Infarction in Rats. *Egyptian Journal of Veterinary Sciences*, 1-11.
3) Adetuyi, F. O., & Ibrahim, T. (2014). Effect of fermentation time on the phenolic, flavonoid and vitamin C contents and antioxidant activities of okra (Abelmoschus esculentus) seeds. *Nigerian Food Journal, 32*(2), 128-137.
4) Aleissa, M. S., Mohammed, A.-Z., Alneghery, L. M., Hasnain, M. S., Almutairi, B., Ali, D., . . . Alkahtani, S. (2022). Comparative study of the anti-diabetic effect of mucilage and seed extract of Abelmoschus esculentus against streptozotocin-induced diabetes in rat model. *Journal of King Saud University-Science, 34*(8), 102297.
5) Alves, S. M., Freitas, R. S., do Val, D. R., Vieira, L. V., de Assis, E. L., Gomes, F. I. F., . . . Clemente-Napimoga, J. T. (2018). The efficacy of a lectin from Abelmoschus Esculentus depends on central opioid receptor activation to reduce temporomandibular joint hypernociception in rats. *Biomedicine & Pharmacotherapy, 101*, 478-484.
6) Anand, P., & Bley, K. (2011). Topical capsaicin for pain management: therapeutic potential and mechanisms of action of the new high-concentration capsaicin 8% patch. *British journal of anaesthesia, 107*(4), 490-502.
7) Azzi, L., Croveri, F., Pasina, L., Porrini, M., Vinci, R., Manfredini, M., . . . Spadari, F. (2017). A burning therapy for burning mouth syndrome: preliminary results with the administration of topical capsaicin. *J Biol Regul Homeost Agents, 31*(2 Suppl 1), 89-95.

8) Bakhsh, H. T., Mokhtar, F. A., Elmaidomy, A. H., Aly, H. F., Younis, E. A., Alzubaidi, M. A., . . . Alsenani, F. (2023). Abelmoschus eculentus seed extract exhibits in Vitro and in vivo Anti-alzheimer's potential supported by Metabolomic and Computational Investigation. *Plants, 12*(12), 2382.
9) Behbehani, J. M., Irshad, M., Shreaz, S., & Karched, M. (2023). Anticandidal activity of capsaicin and its effect on ergosterol biosynthesis and membrane integrity of Candida albicans. *International Journal of Molecular Sciences, 24*(2), 1046.
10) Bereded Sheferie, M. (2023). Effect of seed priming methods on seed quality of okra (Abelmoschus esculentus (L.) Moench) genotypes. *Advances in Agriculture, 2023*(1), 3951752.
11) Chaemsawang, W., Prasongchean, W., Papadopoulos, K. I., Ritthidej, G., Sukrong, S., & Wattanaarsakit, P. (2019). The effect of okra (Abelmoschus esculentus (L.) Moench) seed extract on human cancer cell lines delivered in its native form and loaded in polymeric micelles. *International Journal of Biomaterials, 2019*(1), 9404383.
12) Chaudhury, A., Duvoor, C., Reddy Dendi, V. S., Kraleti, S., Chada, A., Ravilla, R., . . . Kuriakose, K. (2017). Clinical review of antidiabetic drugs: implications for type 2 diabetes mellitus management. *Frontiers in endocrinology, 8*, 6.
13) Cong, X., Zhang, Y., Shi, L., Yang, N.-Y., Ding, C., Li, J., . . . Wu, L.-L. (2012). Activation of transient receptor potential vanilloid subtype 1 increases expression and permeability of tight junction in normal and hyposecretory submandibular gland. *Laboratory investigation, 92*(5), 753-768.
14) Doreddula, S. K., Bonam, S. R., Gaddam, D. P., Desu, B. S. R., Ramarao, N., & Pandy, V. (2014). Phytochemical analysis, antioxidant, antistress, and nootropic activities of aqueous and methanolic seed extracts of ladies finger (Abelmoschus esculentus L.) in mice. *The Scientific World Journal, 2014*(1), 519848.
15) Elkhalifa, A. E. O., Alshammari, E., Adnan, M., Alcantara, J. C., Awadelkareem, A. M., Eltoum, N. E., . . . Ashraf, S. A. (2021). Okra (Abelmoschus esculentus) as a potential dietary medicine with nutraceutical importance for sustainable health applications. *Molecules, 26*(3), 696.
16) Hafiz, T. A., Mubaraki, M., Dkhil, M., & Al-Quraishy, S. (2017). Antiviral activities of Capsicum annuum methanolic extract against herpes simplex virus 1 and 2. *Pak. J. Zool, 49*(1), 251-255.
17) Kalarani, G., Govindharajan, M., Leoney, A., Prabhu, A., Krishnakumar, R., & Dhurikaliyamorthy, S. (2017). Antibacterial effect of Abelmoschus esculentus (okra) extracts on dental caries derived Streptococcus mutans. *Journal of Dental and Medical Sciences, 16*(4), 63-66.
18) Kempaiah, R., & Srinivasan, K. (2004). Influence of dietary curcumin, capsaicin and garlic on the antioxidant status of red blood cells and the liver in high-fat-fed rats. *Annals of nutrition and metabolism, 48*(5), 314-320.
19) Khomsug, P., Thongjaroenbuangam, W., Pakdeenarong, N., Suttajit, M., & Chantiratikul, P. (2010). Antioxidative activities and phenolic content of extracts from okra (Abelmoschus esculentus L.).
20) Kim, C.-S., Kawada, T., Kim, B.-S., Han, I.-S., Choe, S.-Y., Kurata, T., & Yu, R. (2003). Capsaicin exhibits anti-inflammatory property by inhibiting IkB-a degradation in LPS-stimulated peritoneal macrophages. *Cellular signalling, 15*(3), 299-306.
21) Kwok, C. T.-K., Ng, Y.-F., Chan, H.-T. L., & Chan, S.-W. (2025). An Overview of the Current Scientific Evidence on the Biological Properties of Abelmoschus esculentus (L.) Moench (Okra). *Foods, 14*(2), 177.
22) Luthfi, M., Juliastuti, W. S., & Asyhari, N. P. O. (2019). The Effect Of Giving Okra (Abelmoschus Esculentus) Extract On The Increase Of Vascular Endhothelial Growth Factor (Vegf). *Indonesian Journal of Dental Medicine, 2*(2), 35-40.
23) Luthfi, M., Juliastuti, W. S., Risky, Y. A., Wijayanti, E. H., Rachmawati, A. E., & Asyhari, N. P. O. (2020). Expression of fibroblast cells after extraction of wistar rat teeth after topical application of okra fruit (Abelmoschus esculentus) gel. *Infectious disease reports, 12*(Suppl 1), 8726.
24) Merritt, J. C., Richbart, S. D., Moles, E. G., Cox, A. J., Brown, K. C., Miles, S. L., . . . Valentovic, M. A. (2022). Anti-cancer activity of sustained release capsaicin formulations. *Pharmacology & therapeutics, 238*, 108177.
25) Mondal, K., Gowda, K. S., & Manandhar, S. (2019). Anti-hypertensive effect of Abelmoschus esculentus (okra) seed extracts in fructose-induced hypertensive rats. *Indian J Physiol Pharmacol, 63*(2), 175-181.
26) Nie, T., Liu, G., Xiao, Y., Yari, H., & Goorani, S. (2023). Introducing a novel and natural antibiotic for the treatment of oral pathogens: Abelmoschus esculentus green-formulated silver nanoparticles. *Open Chemistry, 21*(1), 20220349.
27) Ong, E. S., Oh, C. L. Y., Tan, J. C. W., Foo, S. Y., & Leo, C. H. (2021). Pressurized hot water extraction of okra seeds reveals antioxidant, antidiabetic and vasoprotective activities. *Plants, 10*(8), 1645.
28) Ortaç, D., Cemek, M., Karaca, T., Büyükokuroğlu, M. E., Özdemir, Z. Ö., Kocaman, A. T., & Göneş, S. (2018). In vivo anti-ulcerogenic effect of okra (Abelmoschus esculentus) on ethanol-induced acute gastric mucosal lesions. *Pharmaceutical biology, 56*(1), 165-175.
29) Palsamy, P., & Subramanian, S. (2008). Resveratrol, a natural phytoalexin, normalizes hyperglycemia in streptozotocin-nicotinamide induced experimental diabetic rats. *Biomedicine & Pharmacotherapy, 62*(9), 598-605.

30) Ping, M.-H. (2020). Hyperin controls the development and therapy of gastric cancer via regulating wnt/β-catenin signaling. *Cancer Management and Research*, 11773-11782.
31) Saravanan, S., Pandikumar, P., Pazhanivel, N., Paulraj, M. G., & Ignacimuthu, S. (2013). Hepatoprotective role of Abelmoschus esculentus (Linn.) Moench., on carbon tetrachloride-induced liver injury. *Toxicology mechanisms and methods, 23*(7), 528-536.
32) Sharma, S. K., Vij, A. S., & Sharma, M. (2013). Mechanisms and clinical uses of capsaicin. *European journal of pharmacology, 720*(1-3), 55-62.
33) Shi, Z., El-Obeid, T., Riley, M., Li, M., Page, A., & Liu, J. (2019). High chili intake and cognitive function among 4582 adults: an open cohort study over 15 years. *Nutrients, 11*(5), 1183.
34) Sinny, D., Ramesh, G., & Stephen, G. (2014). Hypertension: Pathophysiology and Treatment. *J Neurol Neurophysiol, 5*, 6.
35) Srinivasan, K. (2014). Antioxidant potential of spices and their active constituents. *Critical reviews in food science and nutrition, 54*(3), 352-372.
36) Sudhakar, K., Nageshwar, M., & Reddy, K. P. (2018). Protective effect of Okra, Abelmoschus moschatus seed extract on developing brain of rats during pre-and post-natal fluoride exposure. *Int J Pharm Sci Res, 9*(4), 1000-1011.
37) Thongin, S., Den-Udom, T., Uppakara, K., Sriwantana, T., Sibmooh, N., Laolob, T., . . . Ketsawatsomkron, P. (2022). Beneficial effects of capsaicin and dihydrocapsaicin on endothelial inflammation, nitric oxide production and antioxidant activity. *Biomedicine & Pharmacotherapy, 154*, 113521.
38) Wei, D., Guo, S., SU, S., Qian, D., Zhu, Z., Shang, E., & Geng, Z. (2017). Protective effect of okra seed oil on acute gastric ulcer in mice. *Journal of China Pharmaceutical University*, 334-342.
39) Xia, F., Zhong, Y., Li, M., Chang, Q., Liao, Y., Liu, X., & Pan, R. (2015). Antioxidant and anti-fatigue constituents of okra. *Nutrients, 7*(10), 8846-8858.
40) Yohana, W., & Rafisa, A. (2024). Unlocking the potential of capsaicin in oral health. *Biomedical Reports, 21*(5), 153.
41) Yong, Y. L., Tan, L. T.-H., Ming, L. C., Chan, K.-G., Lee, L.-H., Goh, B.-H., & Khan, T. M. (2017). The effectiveness and safety of topical capsaicin in postherpetic neuralgia: a systematic review and meta-analysis. *Frontiers in pharmacology, 7*, 538.
42) Zhang, J., Lu, Y., Yang, X., & Zhao, Y. (2019). Supplementation of okra seed oil ameliorates ethanol-induced liver injury and modulates gut microbiota dysbiosis in mice. *Food & Function, 10*(10), 6385-6398.
43) Zhang, W., Zhang, Y., Fan, J., Feng, Z., & Song, X. (2024). Pharmacological activity of capsaicin: Mechanisms and controversies. *Molecular Medicine Reports, 29*(3), 38.
44) Zhou, Y., Guan, X., Zhu, W., Liu, Z., Wang, X., Yu, H., & Wang, H. (2014). Capsaicin inhibits Porphyromonas gingivalis growth, biofilm formation, gingivomucosal inflammatory cytokine secretion, and in vitro osteoclastogenesis. European journal of clinical microbiology & infectious diseases*, 33*, 211-219.