CORPUS PUBLISHERS

Advance Research in Dermatology & Cosmetics (ARDC)

Volume 2 Issue 2, 2023

Article Information
Received date : January 08, 2023
Published date: June 28, 2023

*Corresponding author
Cristina López Anguas, Catholic University of Murcia, Spain

DOI: 10.54026/ARDC/1012

Keywords
Ginger; Skin; Oxidative stress; Oleoresin

Mini Review

Bioavailability and Bioactivity of Essential Oils in Ginger for Dermatological Clinical Trials

Cristina López Anguas*, Sergio Navarro, Aoife Minihan, Andrea Carpena, Pura Ballester, Raul Arcusa and Pilar Zafrilla

Catholic University of Murcia, Spain

Abstract

Ginger is a member of the *Zingiberaceae* family and whose rhizome, ginger root or ginger is used as a spice for flavouring or in traditional medicine for the treatment of many different disorders. The use of ginger in medicine is due to its many pharmacological activities. (anti-inflammatory, anti-tumorigenic, anti-apoptotic, anti-hyperglycemic, cancer-chemo preventive, and anti-lipidemic). The rhizome of ginger is mainly composed of essential oils in small quantities, oleoresins, mineral salts, sugars, mucilage, starch, gums and organic acids.

The antioxidant and anti-inflammatory properties of ginger can be used to combat many dermatological conditions, cosmetic and medical. Studies show how ginger anti-aging properties, helps with acne, while also alleviating allergic dermatitis-like skin lesions. The aim of the review is to examine how ginger has bioavailability and bioactivity for dermatological uses.

Introduction

The skin is the largest surface barrier organ which protects us against diseases, chemicals, and ultraviolet (UV) light as well as other dangerous environmental agents. These external environmental factors promote the creation of numerous reactive oxidants, which have a role in a variety of physiological and pathological skin processes, either directly or indirectly.

Proteins, lipids, and DNA are all damaged as a result of the oxidative stress. An imbalance between ROS and antioxidants can lead to an elevated oxidative stress level. Some evidence indicates that allergic and inflammatory skin diseases like atopic dermatitis, vitiligo, urticaria and psoriasis are mediated by oxidative stress [1]. There is emerging evidence that oxidative stress can perturb the homeostasis in melanocytes and can play a significant role in the pathogenesis of vitiligo [2]. Atopic dermatitis, also called eczema, is a chronic, inflammatory skin condition that can flare up periodically. No cure has been found for atopic dermatitis. Vitiligo is an acquired chronic depigmenting disease that affects 0.5–2% of the world population [2]. Acne vulgaris is characterized by the production of comedones, papules, pustules, nodules, and/or cysts as a result of pilosebaceous unit blockage and inflammation (hair follicles and their accompanying sebaceous gland) [3]. Psoriasis is a skin condition in which skin cells develop up to ten times faster than they should. The skin becomes rough red spots covered with white scales as a result of this. They can grow on any part of the body, although the majority of them appear on the scalp, elbows, knees, and lower back [4].

Ginger and its bioactives compounds can be considered as potential agents to treat these skin conditions due to their anti-inflammatory, antioxidant properties. Ginger is one of the most widely known spices and a natural antioxidant [5]. *Zingiber officinale* is a perennial herb member of the *Zingiberaceae* family. The composition in bioactive compounds of *Zingiber officinale* varies according to the place where it is grown and the drying techniques.

The most notable compounds of ginger are classified into non-volatile and volatile compounds:

a) The non-volatile compounds consist of an oleoresin (4.0-7.5%). If extracted with solvents, this non-volatile fraction yields pungent, non-pungent principles and an essential oil fraction. The gingerol group (1-(3'-methoxy-4'-hydroxyphenyl)-5-hydroxyalkan-3-ones) is mainly responsible for the pungent taste. Those that have been isolated and identified have been [3]-, [4]-, [5]-, [6]-, [8]- and [10]-gingerol. Shogaols *(phenylacanones)* are more pungent compounds but are present in lower concentration. These come from the dehydration of gingerols and increase in concentration during drying and storage. Others in smaller amounts are gingediols, gingediacetates, gingerdiones and gingerenones.

b) The volatile fraction is due to sesquiterpene derivatives (> 50%), which are responsible for the aroma. Their concentration is constant. Among them are (-)-zingiberene (20-30%), (+)-arcurcumene (6-19%), (-)-β-sesquiphellandrene (7-12%) and β-bisabolene (5-12%). Monoterpene derivatives are also an essential part of them, although in smaller proportion. Among them we find α-pinene, bornyl acetate, borneol, camphene, cineol, citral, cumene, fernesene, geraniol, linalol, myrcene, sabinene [6].

In general terms, the rhizome of *Zingiber officinale* is mainly composed of essential oils in small quantities, oleoresins, mineral salts, sugars, mucilage, starch, gums and organic acids. Ginger contains 1-2% of essential oil [7]. The essential oils are the reservoir of biologically active compounds and there has been increased interest in looking at their properties. There are many bioactive compounds that exhibit antioxidant activity, such as 6-gingerol, 8-gingerol, 10-gingerol and 6-shogaol. Among these ginger compounds, 6-gingerol, the most abundant bioactive compound in ginger, has been extensively studied for its various pharmacological effects including anti-inflammatory, analgesic, antipyretic, chemo preventive, and antioxidant properties [7]. Recent studies have demonstrated that 6-SG exhibited the most potent antioxidant and anti-inflammatory properties.

The ginger can be use in the different cosmetic formulas as:

a) **Powdered ginger:** It is obtained from African roots since they are thicker than Asian roots.

b) **Fresh ginger:** This type of ginger is the most commonly used. It can be made from young roots or mature roots.

c) **Ginger essential oil:** It is obtained through a steam distillation process of dehydrated ginger, i.e. from the dried crushed rhizomes [8].

Antioxidant Activity

Ginger has great antioxidant activity which has been shown both in vitro and in vivo. It is slowly becoming verified that the intake of ginger can increase the concentration of antioxidant enzyme and decrease oxidative stress markers. 6-Shogaol has exhibited the most potent antioxidant and anti-inflammatory properties in ginger, which can be attributed to the presence of alpha, beta-unsaturated ketone moiety [9]. Its antioxidant activity is based on the ability to inhibit the appearance of free radicals as well as the ability to remove them. 6-gingerol has been demonstrated to block xanthine oxidase, an enzyme that catalysis the oxidation of hypoxanthine to xanthine and xanthine to uric acid in the final stages of purine metabolic breakdown, generating reactive oxygen species [10]. Furthermore, this chemical has been shown to increase the activity of two antioxidant enzymes, superoxide dismutase and catalase. Danwilai et al. carried out a pilot study where they concluded that the results of their study demonstrate inflated significantly decreased antioxidant activity and decreased oxidative stress [11].

Anti-inflammatory Activity

Gingers anti-inflammatory properties are yet another of its many biological benefits. One of the body's earliest responses to a danger condition is inflammation and when this inflammation persists, it becomes a concern. Today, it is well understood that inflammation plays a role in a variety of diseases; in fact, researchers are investigating how low-grade systemic inflammation is linked to the development of many pathologies [12].

Eukaryotic cells use the NF- kβ pathway as a regulator of genes that affect cell proliferation and survival. NF- kβ regulates the inflammatory response by increasing the expression of inflammatory target genes such as cytokines, chemokines, and COX2. This enzyme increases the production of proinflammatory cytokines by triggering the creation of certain prostaglandins in response to inflammation. Ginger inhibits inflammatory responses by decreasing NF- kβ, which results in a decrease in cytokine gene expression.

Ginger and Atopic dermatitis

Atopic dermatitis or AD, is a chronic and relapsing inflammatory skin disease often associated with eczema and itch. Staphylococcus aureus (S. aureus), which produces toxins, colonizes both lesioned and normal skin of AD patients. This colonization is caused by a decrease in the production of anti-microbial peptides, which is suppressed by the inflammatory micro-milieu in AD [13].

The experimental data from Wang et al. study on essential oils antibacterial activities revealed that S. aureus was susceptible to ginger essential oils [14].

Ginger and Vitiligo

Vitiligo is a cutaneous autoimmune disease in which CD8+ T lymphocytes destroy melanocytes, resulting in white patches. As many studies have shown, oxidative stress has a crucial role in increasing the onset of vitiligo from the very beginning of the disease [15]. Stressed melanocytes produce intracellular ROS, which are oxygen-based free radicals such as hydrogen peroxide (H_2O_2), superoxide anions, hydroxyl radicals, and singlet oxygen, as a result of exogenous and endogenous stressors [15]. Enzymes that remove or repair damage aid in biomolecule regeneration and recovery from oxidative damage. Antioxidant enzymes act as an intermediate defence between these two layers, detoxifying ROS into less reactive species [16]. Apart from the enzymatic and non-enzymatic antioxidant role, other mechanisms exist to protect melanocytes from oxidative injury. Several recent studies have demonstrated the importance of the nuclear factor E2-related factor 2-antioxidant response element/heme oxygenase-1 (Nrf2-ARE/HO-1) pathway in antioxidant protection. Dysregulated and impaired Nrf2 pathway, for example, was linked to defective autophagy, which likely contributed to melanocyte sensitivity to oxidative stress [15]. Recently it has been shown the Nrf2-ARE signaling in vitiligo melanocytes has been discovered to be disrupted Several drugs, including those recognized as Nrf2 activators and those known to have effects on Nrf2, have been utilized in the treatment of vitiligo with positive results. A variety of compounds have also been demonstrated to protect melanocytes from OS by activating Nrf2 [17]. Ginger has been demonstrated to have antioxidant properties through the nuclear factor erythroid 2-related factor 2 signalling pathway (Nrf2) [18]. Plant phenylpropanoids identified in ginger plant *(Zingiber officinale)*, 6-gingerol, and 6-shogaol and their derivatives are considered as chemo preventive candidates against oxidative stress and cancer due to its property of activating Nrf2-ARE signalling pathway in different types of human cells [19].

Ginger and Acne vulgaris

Acne vulgaris is one of the most common dermatological diseases, affecting 80-85% of teenagers globally. It is triggered by several skin flora, including Propionibacterium acnes and Staphylococcus aureus. Wang et al. performed a study on ginger essential oils on their antioxidant, antifungal, and antibacterial activities [14]. In this study, experimental data showed that S. aureus was susceptible to ginger essential oils. An increased expression of cyclooxygenase-2 (COX-2) and prostaglandin E2 (PGE2) in sebocytes, along with increased release of pro-inflammatory cytokines and lipogenesis, has been identified as another underlying pathogenic mechanism involved in acne pathogenesis [20]. Ginger's anti-inflammatory properties can be explained by its ability to inhibit COX-2 and 5-lipoxygenase enzymes, which causes amino acid metabolism to be suppressed [21]. In Bischoff-Kont et al. study, they concluded that regardless of the manner of inflammatory activity, administration of 6-shogaol to various cell types or in vivo models resulted in the suppression of well-known inflammatory markers and signalling pathways. 6-shogaol inhibited the release of pro-inflammatory cytokines such as interferon, TNF, interleukins, and chemokines by inhibiting pro-inflammatory factors and mediators such as NFB or COX-2, attenuating the levels of iNOS, resulting in lower levels of NO, and attenuating the release of pro-inflammatory cytokines such as interferon, TNF, interleukins, and chemokines [22].

Ginger and Psoriasis

Psoriasis is a chronic inflammatory skin condition marked by keratinocyte overgrowth and inflammation, which leads to epidermal hyperplasia, a characteristic of lesioned psoriatic skin. The elbows, knees, and scalp are the most common sites for psoriatic plaques. There is still no therapy for psoriasis, despite recent research revealing aspects of the pathogenesis and the extensive interplay involving nerves, immune system, endocrine system, and skin cells [23]. Oxidative stress is a key factor in the development and progression of psoriasis, which is known to be caused by a number of factors, including alcohol consumption, smoking, infection, drugs, obesity, cell metabolism, immune response, and pathological state [24]. The production of reactive oxygen species (ROS) is a critical step in the creation of oxidative stress in psoriasis. ROS generally act as second messengers during this process and lead to an increase in the levels of oxidative products which result in the activation of Th1 and Th17 cells and keratinocytes through the MAPK, NF- kβ, and JAK-STAT pathways. This results in a cascade of inflammatory cytokines and growth factors. Nuclear factor-kβ NF- kβ is an essential inflammatory mediator in the pathogenesis of psoriasis; increased expression of NF- kβ has been demonstrated in psoriatic lesions [25]. The phosphorylation of the inhibitor of kappa B kinase (IKK) complex by ROS can activate NF- kβ. [26] H_2O_2, which is transported by AQP3, has been linked to the activation of the NF- kβ signalling pathway in keratinocytes and the pathogenesis of psoriasis [27]. Altered NF- kβ signaling disrupts the balance of apoptotic signals, leading to the upregulation of cyclins and surviving, thereby inhibiting apoptosis. Furthermore, NF-kβ stimulates the synthesis of IL-17 and TNF-, boosting the inflammatory response downstream [24]. Eukaryotic cells use the NF- kβ pathway as a regulator of genes that affect cell proliferation and survival. NF- kβ regulates the inflammatory response by increasing the expression of inflammatory target genes such as cytokines, chemokines, and COX2. This enzyme increases the production of proinflammatory cytokines by triggering the creation of certain prostaglandins in response to inflammation. Ginger inhibits inflammatory responses by decreasing NF- kβ, which results in a decrease in cytokine gene expression [28].

Conclusion

Ginger essential oils contain a variety of bioactive chemicals, including gingerols and shagaols, which have antioxidant and anti-inflammatory effects and can help cure a variety of disorders by lowering inflammation and oxidative stress. Ginger essential oils' bioactivity and bioavailability could be quite beneficial in dermatological trials.

References

1. Okayama Y (2005) Oxidative stress in allergic and inflammatory skin diseases. Curr Drug Targets Inflamm Allergy. 4(4): 517-519.
2. Yang L, Yang F, Teng L, Katayama I (2020) 6-Shogaol Protects Human Melanocytes against Oxidative Stress through Activation of the Nrf2-Antioxidant Response Element Signaling Pathway. Int J Mol Sci 21(10): 3537.
3. Keri JE (2022) Acne Vulgaris. MSD Manual.
4. Gardener SS (2021) Psoriasis. WebMD.
5. Gomez JD, Pradilla D, Alvarez O (2021) A Multiscale Approach to the Design and Manipulation of Oil-in-Water Emulsion-Based Products. Jaskulski M, editor. Int J Chem Eng p. 1-10.
6. Villalba LTP (2014) Evaluation of the anti-inflammatory effect of *Zingiber officinale* Roscoe (Ginger) in experimental animals. Catholic University of Santa María.
7. Guillamás C, Gutierrez E, Hernando A, Ma Jesús Méndez, Sánchez CG, et al. (2017) Anatomy, physiology and pathology of the skin and appendages. (Basic Nursing Techniques).
8. Morales MA (2009) Ginger Cultivation. *Zingiber officinale*. Republic of Costa Rica: Ministry of Agriculture and Livestock.
9. Dugasani S, Pichika MR, Nadarajah VD, Balijepalli MK, Tandra S, et al. (2010) Comparative antioxidant and anti-inflammatory effects of [6]-gingerol, [8]-gingerol, [10]-gingerol and [6]-shogaol. J Ethnopharmacol 127(2): 515-520.
10. Rondanelli M, Fossari F, Vecchio V, Gasparri C, Peroni G, et al. (2020) Clinical trials on pain lowering effect of ginger: A narrativereview. Phytother Res 34(11): 2843-2856.
11. Kwanjit D, Konmun J, Sripanidkulchai B, Subongkot S (2017) Antioxidant activity of ginger extract as a daily supplement in cancer patients receiving adjuvant chemotherapy: a pilot study. Cancer Manag Res 9: 11-18.
12. Rönnbäck C, Hansson E (2019) The Importance and Control of Low-Grade Inflammation Due to Damage of Cellular Barrier Systems That May Lead to Systemic Inflammation. Front Neurol 10: 533.
13. Bieber T (2010) Atopic Dermatitis. Ann Dermatol 22(2): 125-137.
14. Wang X, Shen Y, Thakur K, Han J, Zhang JG (2020) Antibacterial Activity and Mechanism of Ginger Essential Oil against. *Escherichia coli* and *Staphylococcus aureus*. Molecules 25(17): 3955.
15. Yinghan W, Shuli L, Chunying L (2019) Perspectives of New Advances in the Pathogenesis of Vitiligo: From Oxidative Stress to Autoimmunity. Med Sci Monit 25: 1017-1023.
16. Lei XJ, Zhu JH, Cheng WH, Bao Y, Ho YS, et al. (2016) Paradoxical Roles of Antioxidant Enzymes: Basic Mechanisms and Health Implications. Physiol Rev 96(1): 307-364.
17. Lin X, Meng X, Song Z, Lin J (2020) Nuclear factor erythroid 2-related factor 2 (Nrf2) as a potential therapeutic target for vitiligo. Arch Biochem Biophys 696: 108670.
18. Chen H, Fu J, Chen H, Hu Y, Soroka DN, et al. (2014) Ginger Compound [6]-Shogaol and Its Cysteine-Conjugated Metabolite (M2) Activate Nrf2 in Colon Epithelial Cells *in Vitro* and *in Vivo*. ACS Publications. Chem Res Toxicol 27(9): 1575-1585.
19. Schadich E, Hlaváč J, Volná T, Varanasi L, Hajdúch M, et al. (2016) Effects of Ginger Phenylpropanoids and Quercetin on Nrf2-ARE Pathway in Human BJ Fibroblasts and HaCaT Keratinocytes. Biomed Res Int 2173275.
20. Solee J, Lee MY (2018) Kaempferia parviflora Extract as a Potential Anti-Acne Agent with Anti-Inflammatory, Sebostatic and Anti-Propionibacterium acnes Activity. Int J Mol Sci 19(11): 3457.
21. Azimi P, Ghiasvand R, Feizi A, Hariri M, Abbasi B (2014) Effects of Cinnamon, Cardamom, Saffron, and Ginger Consumption on Markers of Glycemic Control, Lipid Profile, Oxidative Stress, and Inflammation in Type 2 Diabetes Patients. Rev Diabet Stud 11(3-4): 258-266.
22. Kont BI, Fürst R (2021) Benefits of Ginger and Its Constituent 6-Shogaol in Inhibiting Inflammatory Processes. Pharmaceuticals (Basel) 14(6): 571.
23. Chen Y, John L (2014) Brain-Skin Connection: Stress, Inflammation and Skin Aging. Inflamm Allergy Drug Targets 13(3): 177-190.
24. Xu F, Xu J, Xiong X, Deng Y (2019) Salidroside inhibits MAPK, NF-κB, and STAT3 pathways in psoriasis-associated oxidative stress via SIRT1 activation. Redox Rep 24(1): 70-74.
25. Goldminz AM, Au SC, Kim N, Gottlieb AB, Lizzul PF (2013) NF-κB: an essential transcription factor in psoriasis. J Dermatol Sci 69(2): 89-94.
26. Nguyen TT, Ung TT, Li S, Lian S, Xia Y, et al. (2019) Metformin inhibits lithocholic acid-induced interleukin 8 upregulation in colorectal cancer cells by suppressing ROS production and NF-kB activity. Sci rep 9(1).
27. Chikuma MH, Satooka H, Watanabe S, Honda T, Miyachi Y, et al. (2015) Aquaporin-3-mediated hydrogen peroxide transport is required for NF-κB signalling in keratinocytes and development of psoriasis. Nat Commun 7454: 23-26.
28. Wang J, Ke W, Bao R, Hu X, Chen (2017) Beneficial effects of ginger *Zingiber officinale* Roscoe on obesity and metabolic syndrome: a review. Ann N Y Acad Sci 1398(1): 83-98.