Pharmacological Properties of Ginger Plant

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ABSTRACT

The current mode of treatment based on synthetic drugs is expensive and also causes genetic and metabolic alterations. However, safe and sound mode of treatment is needed to control the diseases development and progression. In this regards, medicinal plant and its constituents play an important role in diseases management via modulation of biological activities.

KEYWORDS: *Ginger, anti-tumour activity, anti-microbial activity, neuro-protector effect.*

Ginger (*Z. officinale*) is an important plant with several medicinal, ethnomedicinal and nutritional values. Among different biological activities, ginger has demonstrated anti-inflammatory, antioxidant, anti-emetic, analgesic, and antimicrobial activities. Overall, they can be mainly ascribed to 6-gingerol and 6-shogaol, which represent the major compounds in ginger rhizomes, among hundreds of molecules isolated.

According to recent literature, ginger anti-inflammatory properties are mediated by the inhibition of 5-lipoxygenase or prostaglandin synthetase, which reduces biosynthesis of prostaglandins, leukotrienes and pro-inflammatory cytokines such as interleukin (IL)-1, IL-8; tumor necrosis factor (TNF)-α, and nuclear factor κB (NFκB). One clinical trial, indeed, reported its beneficial effects in reducing pro-inflammatory cytokines of patients suffering from osteoarthritis. In addition, the antioxidant activity of the *Z. officinale* extract has been in vitro demonstrated to inhibit the hydroxyl radicals and the lipid peroxidation products. This was consistent with further studies in animal models, which revealed as it acted by enhancing antioxidant enzyme defenses and serum glutathione. Similar effects were attributed to ginger single constituents, namely, 6-gingerol, 8-gingerol, 10-gingerol, and 6-shogaol as well as geranial and neral, α-zingiberene, camphene, α-farnesene, β-sesquiphellandrene and zingerone. 6-Shogaol, in particular, showed the most potent antioxidant and anti-inflammatory properties, due to the presence of α, β-unsaturated ketone moiety, while zingerone exhibited, in mice, protection against radiation-induced toxicity, increasing antiapoptotic molecules (Bcl-2) while reducing the proapoptotic ones (Bax).

Together, the above reported antioxidant and anti-inflammatory properties of ginger support its preventive role against a plethora of chronic-degenerative diseases, including cancer, cardiovascular disorders, and diabetes.

Although still under debate, anticancer activity of ginger is, as mentioned above, mainly related to the high content of 6-gingerol and 6-shogaol. Ginger and related bioactive molecules, indeed, are effective in controlling, in vitro, viability and invasiveness of colorectal, gastric, ovarian, liver, skin, breast, and prostate cancer cells. Recent evidence supports, in particular, the role of zingerone supplementation as chemopreventive agent, reducing cancer incidence in dimethyl hydrazine treated rats; the mechanism included the inhibition of cell proliferation, the induction of cell apoptosis, and the suppression of NF-κB and heme oxygenase (HO)-1 expression. The proapoptotic effect and the promotion of cell cycle arrest in hepatoma and prostate cancer cells were ascribed to the activation of

caspase cascade and the impairment of the nuclear translocation of NF-κB, particularly by 6-gingerol, which was also able to inhibit angiogenesis and invasiveness in the murine cancer models. Anti-angiogenetic activity of 6-gingerol occurs by the inhibition of the vascular endothelial growth factor (VEGF), while its anti-metastatic activity could be ascribed to regulation of matrix metalloproteinases 2/9 transcription. Another active compound contained in ginger is zerumbone, which induced apoptosis in pancreatic carcinoma cells, through the p53 signal pathway and increasing the activity of caspase-3. In humans, the chemopreventive effect of ginger has been mainly investigated against colorectal cancer, in virtue of its anti-inflammatory effects, similarly to those of aspirin. Ginger significantly lowered COX-1 protein expression in patients at increased risk for colorectal cancer, but with no effect on eicosanoid levels.

The role of ginger in reducing cardiovascular diseases and diabetes is highly related to its ability in controlling body weight, and reducing serum levels of glucose and lipids. Indeed, a study showed that ginger significantly decreased glucose, total cholesterol, triglycerides, free fatty acids, low density lipoproteins (LDL) and very low density lipoproteins (VLDL), whilst raised high density lipoproteins (HDL) in serum of rats with diabetic or fed with a high fat diet . These effects are mainly related to zingerone, and less to shogaols. Recently, in high fat diet fed animals, zingerone and 6-gingerol both possessed high lipolytic activity: the former by increasing the activity of norepinephrine-sensitive lipases, enhancing basal lipolysis and isoprenaline-induced lipolysis in adipocytes, while the latter by reducing the levels of fatty acid synthase and adipocyte-specific fatty acid binding protein. In addition, 6-gingerol could prevent diabetes via the improvement of adipocyte dysfunction, since it caused the inhibition of the TNF-α mediated downregulation of adiponectin expression, as well as arachidonic acid pathway in turn inhibiting anti-platelet aggregation. A clinical trial showed that ginger consumption enhanced thermogenesis and reduced feeling of hunger, suggesting a potential role in weight control. In patients with type 2 diabetes, ginger improved glycemic index, total antioxidant capacity, insulin sensitivity and lipid profile, reducing c-reactive protein and prostaglandin E_2 . In peritoneal dialysis patients, for whom one of the major risk factors for cardiovascular disease is serum triglyceride concentration, the latter resulted as being reduced by daily administration of 1000 mg ginger.

As antimicrobial agent, ginger extract exhibited higher antifungal than antibacterial effects in vitro, showing anti-*Candida* activity against strains isolated from patients. This finding was related to the high anti-biofilm activity against *C. albicans*, at concentrations ranging from 0.625 mg/mL to 5 mg/mL. Ginger was also effective against other fungal strains, such as *Fusarium* spp., and it inhibited the growth of fungi that were resistant to amphotericin B and ketoconazole. Among bacteria, it showed efficacy against *Pseudomona aeruginosa*, *Staphylococcus aureus*, *Acinetobacter baumannii* , *Escherichia coli*, *Bacillus subtilis* and *Salmonella typhi* . Furthermore, 6-gingerol and 12-gingerol showed antibacterial activity against periodontal bacteria, so that a clinical trial was performed to test a polyherbal mouthwash containing, among the others, the hydroalcoholic extract of *Z. officinale*; it was worth noting that it was effective in reducing gingival and plaque indices similarly to chlorhexidine mouthwash. On the other hand, the antidiarrheal activity of 6-gingerol has been accredited to its ability to bind to the toxin produced by *Vibrio cholera*, rather than due to direct antibacterial activity.

Nausea and emesis are among the most common adverse effects of chemotherapeutics as well as frequent events during pregnancy and post-surgery anesthesia. At preclinical level, 6-gingerol showed efficacy in rats against cisplatin-induced nausea and vomiting. Along these lines, a number of clinical trials and related systematic reviews and meta-analysis now support the efficacy of ginger in reducing hyperemesis during pregnancy as well as in alleviating nausea and vomiting during chemotherapy, especially for breast cancer. Similarly, ginger appeared to reduce post-anesthesia

emesis in gynecological surgery and after antitubercolosis drug administration.

Analgesic and antipyretic activities of ginger can be ascribed to 6-gingerol, as shown in rats. Injection of 10 μg of 6-gingerol into the rat spinal cord was found to be effective in ameliorating neuropathic pain, via vanilloid receptor-mediated pathway. In humans, ginger intake produced pain relief in primary dysmenorrhea similarly to conventional analgesic drugs, while remaining controversial in the case of ostheoartritis. In addition, it showed an abortive effect against migraines, particularly when administered early and in the presence of mild migraines.

Further activities include gastroprotective, immunomodulatory, anti-allergy and hepatoprotective properties, in all cases mainly related to 6-gingerol. In particular, ginger reduced the gastropathy induced by some drugs, such as anti-tuberculosis agents and nonsteroid anti-inflammatory drugs.

Due to these overwhelming activities supported by preclinical evidence, people of different cultures have traditionally applied ginger as a medicinal agent for a long time ago. A vast body of anecdotal evidence, which can be used to support ginger uses and efficacy, can be found in various traditional systems of medicine belonging to Indian, Unani, Chinese, Japanese and other cultures .

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