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Antimutagenic and cancer preventive potential of culinary spices and their bioactive compounds

Krishnapura Srinivasan

Department of Biochemistry, CSIR - Central Food Technological Research Institute, Mysore 570 020, India

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ABSTRACT

Spices significantly contribute to human health through their bioactives. They exert multiple health-beneficial influences including anti-cancer potential. Among natural chemopreventive bioactives capable of inhibiting, retarding, or reversing the multi-stage carcinogenesis, considerable attention has been focused in recent decades on spice derived phytochmicals. Spices with proven anticarcinogenic effects in animal models of cancer include turmeric, garlic, ginger, and black cumin. These spices showed chemopreventive effects against cancers of the skin, forestomach, pancreas, liver, colon, and oral cancer in experimental models. Bioactives of these spices reduce oxidative stress by decreasing free radicals concentration, impede cell division and promote apoptosis in cancerous cells. Additionally, they regulate inflammation and immunocompetence, contributing to cancer prevention. The anticancer potential of curcumin has also been evidenced in clinical studies. Curcumin of turmeric is understood to impede carcinogenesis at all three stages. Curcumin's anticarcinogenic effect is partly mediated through its inhibition of the transcription factor NFkB and inhibition of proinflammatory pathways. Curcumin induces apoptosis, suppress proliferation and angiogenesis. Use of spices as food adjuncts is a promising approach to reduce the risk of cancer. Although the cancer preventive effects have not been conclusively proven in humans, these spices deserve to be considered as nutraceuticals for deriving anticancer influences.

1. Introduction

Spices are consumed as food adjuncts to enhance sensory quality of foods and are also used in traditional systems of medicine because of their physiological effects beneficial to human health. With the knowledge of the chemistry of the spice bioactive compounds, their beneficial health effects have been exhaustively investigated in recent decades [1–5]. Through their bioactives, spices significantly contribute to human health and may be considered as the first ever nutraceutical. By rendering foods palatable even in the absence of salt and fat, spices assist in achieving a healthy intake of sodium and fat. The multiple health beneficial attributes of spices documented from numerous animal studies and clinical trials include digestive stimulant action, protection to the gastrointestinal tract, hypolipidemic effect, antidiabetic influence, antilithogenic property, antioxidant potential, anti-inflammatory property, and cancer preventive potential (Fig. 1). The cholesterol-lowering and antioxidant properties of specific spices have far-reaching nutraceutical implication.

Considerable attention has been focused in recent years in identifying naturally occurring chemopreventive substances capable of inhibiting, retarding, or reversing the multi-stage carcinogenesis. Since oxidative stress is the primary cause in many pathological processes, reduced oxidative stress is implicated in the prevention of degenerative diseases. Dietary plants contain substances that promote endogenous defense against oxidative stress. Phenolic compounds of plant origin have been reported to possess substantial antimutagenic and anticarcinogenic activities. Both epidemiological evidences and preclinical research suggest that phenolic phytochemicals particularly, epigallocatechin gallate from tea, curcumin from turmeric and isoflavones of soya bean possess cancer chemopreventive properties [6]. Such naturally occurring polyphenols have been the subject of numerous mechanistic studies in cells. Turmeric/its yellow colouring principle curcumin, garlic/its sulfur compounds have been shown to be antimutagenic in several experimental systems. Spice constituents with known anticarcinogenic effects in animal models of cancer include turmeric, garlic, ginger, and black cumin (Figs. 2 and 3). The anticancer potential of curcumin has evidenced by both preclinical and clinical studies. These spices have been found to have chemopreventive effects against cancers of the skin, forestomach, pancreas, liver, colon, and oral cancer in experimental models. Chemoprevention by phytochemicals has emerged as a promising and pragmatic medical approach to reducing the risk of cancer. The naturally occurring antioxidants which are radical scavengers have been found to be effective in inhibiting the induction of carcinogenesis by a wide variety of chemical carcinogens

E-mail address: ksri.cftri@gmail.com.

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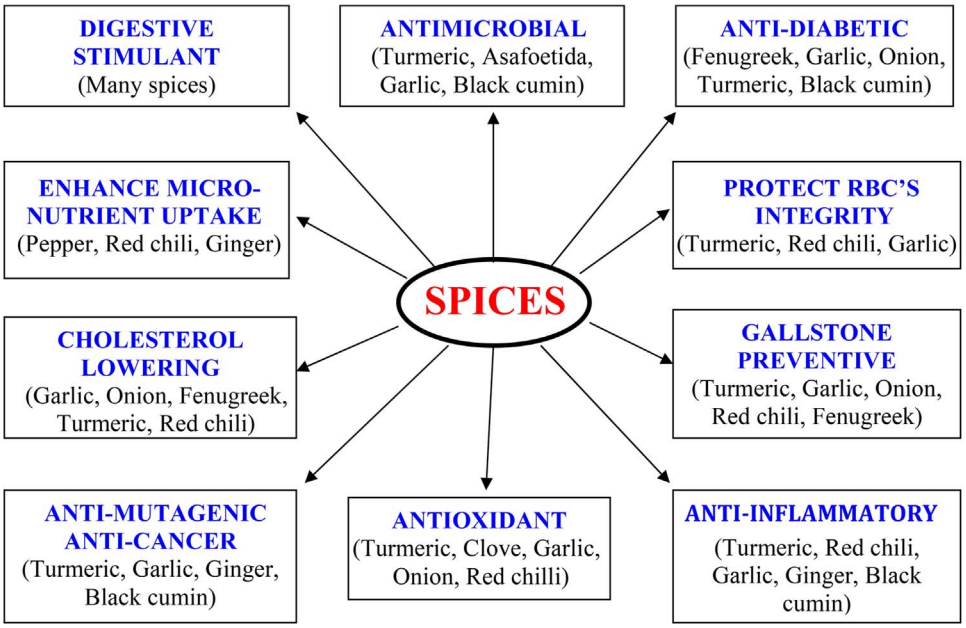

Fig. 1. Multiple health effects of spices.

[7].

In vitro studies and rodent *in vivo* studies suggest that spices have a chemopreventive effect against the early initiating stages of cancer. As yet, the anticarcinogenic effect of spices in humans is not confirmed. Spices (or their extracts/constituents) with known anticarcinogenic effects in animal models of cancer include turmeric, garlic, and ginger. Spices may act through several mechanisms to provide protection against cancer. Spices contain several natural antioxidant biomolecules lipid-soluble that may protect against the generation of genotoxic lipid peroxidation peroxides. These bioactives of spices can protect against oxidative stress and inflammation, both of which are a risk factor for cancer initiation and promotion. The potential of spice-derived phytochemicals for cancer prevention has been reviewed a decade back [8,9]. The present one is intended to update the available information on this particular nutraceutical aspect of dietary spices.

Several spices are understood to have the ability to inhibit carcinogen bioactivation, decrease free radicals concentration, impede cell division and promote apoptosis in cancerous cells. Additionally, they can regulate inflammation and immunocompetence; these attributes contribute to their cancer prevention potential. Consumption of about 1 g/day of herbs/spices being a better source of antioxidants significantly contributes to total antioxidant intake (> 1 mmol) [10]. They may be particularly important in decreasing oxidative damage due to environmental stress leading to degenerative diseases including cancer. Spices that are experimentally documented/epidemiologically evidenced to influence the risk of cancer are discussed hereunder. The potential of turmeric (curcumin), garlic (sulfur compounds), ginger (6-gingerol), black cumin (thymoquinone), allspice, saffron, caraway, cloves (eugenol), and red chili (capsaicin) in cancer prevention has been established. Additionally, the mechanism by which these spices mediate anticancer effects is also becoming increasingly evident. The mechanisms of action of their active constituents and their potential in cancer prevention have been reviewed [8,9].

2. Antioxidant activity contributing to chemopreventive potential

While the generation of reactive oxygen and nitrogen radicals during metabolism is a normal process, excessive free radicals generation over-balancing the rate of their removal by endogenous antioxidant machinery results in oxidative stress. Oxidative stress is responsible for the initiation and propagation of degenerative disease processes such as CVD, inflammatory diseases, cancer, and