Review Article

Traditional Indian spices and their health significance

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India has been recognized all over the world for spices and medicinal plants. Both exhibit a wide range of physiological and pharmacological properties. Current biomedical efforts are focused on their scientific merits, to provide science-based evidence for the traditional uses and to develop either functional foods or nutraceuticals. The Indian traditional medical systems use turmeric for wound healing, rheumatic disorders, gastrointestinal symptoms, deworming, rhinitis and as a cosmetic. Studies in India have explored its anti-inflammatory, cholekinetic and anti-oxidant potentials with the recent investigations focusing on its preventive effect on precarcinogenic, anti-inflammatory and anti atherosclerotic effects in biological systems both under in vitro and in vivo conditions in animals and humans. Both turmeric and curcumin were found to increase detoxifying enzymes, prevent DNA damage, improve DNA repair, decrease mutations and tumour formation and exhibit antioxidative potential in animals. Limited clinical studies suggest that turmeric can significantly impact excretion of mutagens in urine in smokers and regress precancerous palatal lesions. It reduces DNA adducts and micronuclei in oral epithelial cells. It prevents formation of nitroso compounds both in vivo and in vitro. It delays induced cataract in diabetes and reduces hyperlipidemia in obese rats. Recently several molecular targets have been identified for therapeutic / preventive effects of turmeric. Fenugreek seeds, a rich source of soluble fiber used in Indian cuisine reduces blood glucose and lipids and can be used as a food adjuvant in diabetes. Similarly garlic, onions, and ginger have been found to modulate favourably the process of carcinogenesis.

Key Words: turmeric, curcuminoids, precancer, DNA damage, detoxification, tumors, antimutagens

INTRODUCTION

Mounting health care costs and increased desire to maintain good health and quality of life have focussed the researchers' and public health scientists' attention on the diet, phytonutrients, disease prevention and health promotion. Biomolecules in the plants play a crucial role in health maintenance and promotion.[1] In Asian countries; particularly, India, China, Japan and Korea; there is a longstanding tradition and culture of attributing healing properties to foods and plant materials. They have an extra-ordinary place in the realm of traditional cures as medicines.[2.] There is a treasure house of knowledge, which needs to be explored to establish the scientific basis of its benefits. Phytochemicals in spices, which primarily serve in plant protection, are considered vitamins of the 21st Century. They are also less toxic compared to drugs. This article captures some recent scientific findings on turmeric, fenugreek, mustard, ginger, onions and garlic, which are common spices and have a distinct place in folk medicine in several of Asian countries.

STUDIES ON TURMERIC

Turmeric cultivation in India occupies 60% of the total area intended for spices and condiments. It is not only an ancient but also a highly cultivated Asian spice and used in countries like India, China, Malaysia, Pakistan, Bangladesh, Indonesia, Taiwan, Haiti, Jamaica and El-Salvador. Traditionally turmeric is used in a variety ways for different diseases, due to its kaleidoscopic properties[3], for example as a general tonic, stimulant, cosmetic and for the treatment of coughs, colds, soar throats, asthma and dyspepsia including peptic ulcers. It is also used as a deworming agent and as a paste for some viral diseases such as chicken pox, small pox and measles. It is liberally used in arthritis and for wound healing. These traditional uses are a reflection of its pleiotropic effects. Current literature abounds in scientific evidences supporting its traditional uses and evidence based science clearly shows that turmeric and its active constituents, particularly curcuminoids can be used for a variety of disorders.[3]

Turmeric is a popular spice derived from the root of Curcuma longa Linn, a member of the ginger family. The powder and its active principle, a group of curcuminoids, are widely used as: culinary spices, preservatives, food additives, cosmetics, and as oleoresin in food and pharmaceutical industries. In the last two decades, there has been considerable interest among the biomedical scientists to explore the possible therapeutic benefits of turmeric and its active principle, curcuminoids. A considerable amount of work has been carried out to explain its molecular, cellular, biochemical and pathological mechanisms to establish its potential as a therapeutic agent for many chronic diseases.[4]

CHEMICAL AND NUTRITIONAL COMPOSITION

Curcuma longa Linn or turmeric is a tropical plant native to

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South and Southeast tropical Asia. It is a rhizomatous herb that belongs to the family Zingiberaceae. The major species is genus Curcuma longa Linn which is of commercial value. The rhizomes, on maturity, are steeped in boiling water, sun dried and polished to obtain the turmeric sticks. The powder form is used in various dishes. Turmeric contains essential oils, fatty oils and 2-5% curcuminoids.[5]. Certain varieties, contain up to 9% curcuminoids. It has all proximate principles such as carbohydrates, proteins and fats and provides all nutrients in small quantities. Turmeric is fairly rich in omega-3 fatty acids. Curcuminoids are polyphenolic compounds with a β-diketone moiety. The 3 types of curcuminoids, namely Curcumin I, II and III, differ with regard to their hydroxyl and methyl groups. Current efforts in research are focused on evidence-based science to determine the functional benefits of their bioactive compounds.[3] Whole turmeric or the extracted curcuminoids appear to be active in many disease processes with specific reference to chronic ailments such as cardiovascular, degenerative, infective and inflammatory disorders as well as cancers.

ANTIMUTAGENIC EFFECTS

The antimutagenic potential of turmeric was assessed against the ubiquitous pollutant benzo(a)pyrene [B(a)P] in rats. Turmeric, at 1, 5 and 10% of the diet, were fed to the rats for three months. At the end of each month, after giving 5 mg of B(a)P per rat, urine samples were collected for 24 hours in which mutagens were quantitated. The salmonella strains of TA98 and TA100 with and without S9 fraction were used for the quantitation of mutagens. Mutagens in urine were significantly reduced by dietary exposure to turmeric. No additional effects were observed beyond 1 month. Further studies were done with 0.1 and 0.5 % turmeric with B(a)P and 3 methyl cholanthrene. Dose dependent results were observed with the 0.5% turmeric in the diet, indicating a potent effect even against a strong inducer such as methylcholanthrene.[6]

As curcuminoids are important constituents of turmeric and is similar to ellagic and ferulic acids which are antimutagens, the antimutagenic effects of curcuminoids were assessed in the animals with methods described in the previous study. Curcumin, with or without S9 fraction, significantly reduced mutagens at all levels within four weeks of feeding,. The doses correspond to 0.5 to 5% of turmeric in the diet. The parahydroxy groups/diketone moiety are considered important for activity.[7]

PROTECTIVE EFFECTS ON DNA

In rats treated with dietary turmeric and curcumin for one month, both the number of adducts and the micrograms of adducted DNA were significantly impacted by 0.1% turmeric and 0.03% of curcumin. This was determined with the use of P32 post label assay. The percentage of reduction ranged from 61 to 70% for 0.1 to 3% turmeric respectively while curcumin (0.03%) resulted in 92% reduction.[8]

A more recent study showed that breaks in the DNA strand in the peripheral cells were effectively repaired by curcumin and S.cerevisiae exposed to χ irradiation. The protective effect of curcumin on B(a)P induced DNA damage in human peripheral blood , as assessed by comet assay, showed a dose-dependent inhibitory effect.[9]

TURMERIC AND CURCUMIN ON XENOBIOTIC METABOLISM

Ingested environmental chemicals need to be eliminated from the body to protect against toxicity. The body has a defence system in the form of drug metabolising enzymes located in the GI tract and liver and certain extra hepatic tissues like the kidneys and lungs. The liver and the GI tract act as first line of defence against lipophilic substances. Several plant materials known to be inhibitors of carcinogenic process are reported to enhance the host detoxification mechanisms and act as blocking agents. Enzymes such as aryl hydrocarbon hydroxylase (AHH), Uridine diphosphoglucuronide transferase (UDPGT) and Glutathione-S-transferase(GSHT) were therefore assessed in rats after 4 weeks of turmeric and or curcumin feeding. The AHH was not altered either by turmeric or curcumin feeding neither in the liver nor in the GI tract. However, GSHT activity was significantly elevated both in the liver and in the intestine at low levels of turmeric and curcumin intake. Elevation ranged from 25-30%. GSHT is one of the versatile enzymes that mop up electrophilic substances. The increased in GSHT activity in animals fed large amounts of cruciferous vegetables and fruits correlates well with their anticarcinogenic potential in forestomach tumours induced by B(a)P. The non-stimulatory effect of turmeric and curcumin on AHH as against inducing effects on GSHT would ultimately decrease the load of carcinogen on the body.[10] Several other enzymes such as quinone reductase, epoxide and hydrolase are also increased by both turmeric and curcumin.[3]

TURMERIC AND CURCUMIN AS ANTIOXIDANTS

Turmeric and curcumin show antioxidant activity in vitro. The antioxidant effects of turmeric and curcumin were therefore evaluated in vivo where oxidant damage was induced by paracetamol and DMBA. Markers such as MDA levels as an indicator of lipid peroxidation, glutathione in liver homogenate, superoxide dismutase and glutathione peroxide were estimated. Thiobarbituric acid reactive substances were much lower in turmeric and curcumin treated rats when compared to controls and so was the case with ALT levels in serum, indicating that liver damage due to the paracetamol metabolite N-acetyl amino-paraamino benzoquinone was counteracted by curcumin. This suggests that the oxidative metabolite of paracetamol is detoxified by increased activity of GSHT.[3]

TUMOUR INHIBITION

As oral cancers are highly prevalent in India, the experimental model of hamster cheek pouch was employed to study the effects of turmeric and curcumin on DMBA induced tumour genesis. The burden of tumours and the number of tumours per animal were significantly reduced at 1% turmeric in the diet. The tumours were larger in size in the control groups as compared to those that received either turmeric or curcumin.[11] However, curcumin effects varied between groups. Since GI tract tumours such as oesophageal and stomach cancers are widely prevalent in several states of India, it was considered necessary to assess its effects on the initiation promotion model of fore-stomach tumours, induced by B(a)P, in mice. Histopathological grading was done on a scale of 1-10 of which 6-10 is malignant proliferation. The proliferation index in the treated groups was significantly lower. Turmeric was effective during both the initiation and post-initiation phases while curcumin appears to be effective only during the initiation phase, with minimal effects on post-initiation phase. From a pathological point of view, the evolving carcinogenic process is a sequential change from a normal homogenous group to a more heterogeneous group and turmeric appears to control pre-malignant and precancerous lesions as well malignant transformation.[3]

EFFECT OF TURMERIC ON IN VIVO NITROSATION

Since nitrosocompounds are known to increase the risk of the development of gastrointestinal tract cancers and antioxidants such as selenium and vitamin C inhibit nitrosation, turmeric was assessed for its nitrosation inhibition activities in human volunteers. Turmeric, even at low concentrations, inhibited (22.7%) nitrosoproline excretion.[3]

MOLECULAR MECHANISMS

Curcuminoids have a wide sweep of complex molecular actions. It arrests the cell cycle (anti-proliferative), promotes differentiation, inhibits several biochemical and molecular process (signal transduction, transcription), oncogenic expressions to growth factors, angiogenesis and promotes apoptosis. It inhibits inflammatory process through the reduction of TNF-alpha and cytokines, chemokines and prostaglandin inhibition.[4]

ANTI-ATHEROSCLEROTIC EFFECTS

In a natural mutant model of obesity, turmeric (at 1 and 5% of the diet) had significantly reduced cholesterol and triglyceride concentrations while increasing HDL cholesterol, within 4 weeks. Further evidence indicates that it reduces the oxidation of LDL, blood glucose and renal lesions in diabetes. In addition, it had been demonstrated to reduce platelet aggregation, cyclooxegenase, thromboxane, smooth muscle cell proliferation and endothelial dysfunction.[3]

Both turmeric and curcumin, due to their antioxidant and anti-inflammatory activity, have been demonstrated to counteract several disorders such as myocardial infarctions, chronic inflammatory lung diseases, pancreatitis, inflammatory bowel diseases, neurodegenerative diseases, hepatic and lung damages as well as muscle injuries and cystic fibrosis.[3] Curcumin can also impact on the process of cataractogenesis and delays galactose-induced cataracts formation in rats.[12]

CLINICAL TRIALS

Several trials, albeit not very well designed, have shown positive effects. The antimutagenic effects of turmeric were assessed in humans who were known to excrete large amounts of mutagens in their urine. Turmeric, when administered in doses of 1.5 g/day for 30 days (extrapolated doses from animal experiment) exhibited strong inhibition of urinary mutagens within a short period of 15 days.[13] A limited clinical straight trial was conducted in a group of reverse smokers who are known to be at high risk of palatal cancers. A dose of 1g/day of turmeric was administered for a period of 9 months, the results of which suggested that it had a significant impact on the regression of precancerous lesions and also impacted genotoxic damage.[3]

TOXICITY

Turmeric has been in use from time immemorial as a flavouring and colouring agent and in folklore as a medicament. Toxicology studies on curcumin in various species of animals have yielded no toxic effects. Human clinical trials have demonstrated no toxic effects at doses of 1-8g / day / 6-8 months. (see ref 3 for cross ref.)

EFFECT OF COOKING

As turmeric, in the Indian culinary practices, is usually either boiled or fried, the antimutagenic effects of boiled or friend turmeric were assessed in E.coli PQ37 based on the measure of SOS DNA repair.[7] It was evident that boiled or fried turmeric evoked a similar SOS response, indicating that cooking at high temperatures is unlikely to destroy the antimutagenic potentials of turmeric.

FENUGREEK AND ITS BIOLOGICAL EFFECTS

Fenugreek, a native of South East Europe and West Asia belongs to the family of leguminacae and is an annual herb. The dried seeds of fenugreek are used as a spice while the leaves are used as a vegetable in the Indian culinary arts. Fenugreek seeds is a rich source of protein, fibre and omega 3 fatty acids while the leaves are sources of beta-carotene, iron, calcium, magnesium, potassium and vitamin C. India is one of the major producers and exporters of fenugreek.

HYPOGLYCEMIC EFFECTS

Since fenugreek is a rich source of soluble fiber, several experiments were performed in animals to assess its effects on lipids and blood glucose. In a metabolic study with a crossover design in NIDDM patients, when 100g of defatted fenugreek seed powder was administered for a period of 10 days, significant reduction in glucose levels and increased glucose tolerance was observed.[14] A reduction in serum insulin levels was also documented. When subjects received fenugreek for a period of 10 and 20 days, there was not only a significant reduction in blood glucose but also a significant reduction in cholesterol, triglycerides and urinary sugar levels. The gel forming characters of fenugreek fiber reduces gastric emptying, glucose absorption and the insulin response. In a majority of patients, a mild improvement in clinical symptoms such as polydipsia and polyuria were observed with a reduction in anti-diabetic drug doses. Incorporating just around 25g fenugreek seeds in the daily diet can serve as an effective supportive therapy in the management of diabetes.

A study on glucose disposition was undertaken in type II diabetics before and after a diet consisting of fenugreek (25g) in unleavened bread. During the experimental period, the intake of fibre was 42g as compared to 30g in the control group. There was a significant reduction in the area under the plasma glucose curve (AUC). The half-life of glucose was shorter and metabolic clearance of glucose was higher, RBC insulin receptors registered a significant increase. The results of the insulin binding sites coupled with the observations on insulin levels indicated better peripheral glucose utilization. Recent studies attribute the hypoglycemic effects to the amino acid, 4-hydroxyisoleucine which may have effects on pancreatic beta cells.

BIOPOTENCY OF ONION, GARLIC, MUSTARD AND GINGER.

Garlic and ginger have many therapeutic attributes. Antimicrobial, antithrombotic, antiinflammatory and anticancer activity have been reported.[15,16] Spices such as mustard, allium and ginger have been demonstrated to be antimutagenic, inducers of detoxification, and preventers DNA damage in vitro.[17,18,19]

CONCLUSION

The relevance of the innumerable actions of spices shown in vitro, have to be demonstrated in vivo. The diversity of their cellular actions supports their possible beneficial effects on various chronic diseases. More rigorous clinical trials are needed to determine long-term benefits. The integration of knowledge is required to determine their effect in natural human settings. Turmeric, through its kaleidoscopic effects, appears to be truly a spice of life. Food based approaches for enhancing the intake of spices and phytochemicals can offer an avenue to greatly impact the onset and progression of chronic diseases, oxidant stress and ageing. Although the chemopreventive approach is a recognized strategy, public health action should be directed at increases in the consumption of foods / herbs / spices / beverages, which posses a package of protective phytonutrients. The phytoprotectants act as bioenhancers of several physical and biochemical processes. For chronic disorders, chemoprevention may not be a feasible strategy except for individuals at risk. Dietary prescription as a public health measure will be sustainable and cost effective. Spices such as turmeric, fenugreek, mustard, ginger, onion and garlic have a wide variety of bio functions and their additive or synergistic actions are likely to protect the human body against a variety of insults. Traditionally spices, as part of the diets, have holistic effects on human health.

AUTHOR DISCLOSURES

Kamala Krishnaswamy, no conflicts of interest.

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