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Spices as influencers of body metabolism: an overview of three decades of research

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Abstract

The safety of the consumption of spices – turmeric, red pepper and black pepper and their respective active principles was established in animal studies by observing the influence on growth, organ weights, nitrogen balance and blood constituents upon feeding at levels close to human intake as well as upto 100-times the normal human intake. Exhaustive animal studies documented the beneficial influence of turmeric/curcumin, red pepper/capsaicin, and garlic on lipid metabolism, especially anti-hypercholesterolemic effect of the three spices and anti-lithogenic effect of curcumin and capsaicin. The anti-diabetic effects of turmeric/curcumin, onion and cumin seeds were also evidenced with particular ameliorative influence of curcumin and onion on diabetic nephropathy. The antioxidant effects of curcumin (of turmeric), capsaicin (of red pepper) and eugenol (of clove) were evidenced both in in vitro and in vivo systems and the consequential health beneficial anti-inflammatory influence in experimentally induced arthritis was documented. The mechanism of digestive stimulant action of common spices examined in experimental animals revealed to be mediated through phenomenal stimulation of bile secretion with an enhanced bile acid concentration (ingredients essential for fat digestion and absorption) and an appropriate stimulation of the activities of digestive enzymes of pancreas and small intestine. The protective influence of hypolipidemic spices – curcumin, capsaicin and garlic on the altered fluidity of erythrocytes under hypercholesterolemic situation was evidenced in experimental animal models. Antioxidant spices were also shown to greatly reduce LDL-oxidation and also modulate the synthesis of prostaglandins and leukotrienes. Several spices or their extracts were also found to beneficially inhibit platelet aggregation. All these observations strongly indicate that many spices and their active principles are excellent nutraceuticals.

Keywords: Spices; Safety of consumption; Physiological effects; Hypolipidemic; Antioxidant; Digestive stimulant; Anti-diabetic

1. Introduction

Spices – the natural food additives contribute immensely to the taste and flavour of our foods. These esoteric food adjuncts have been in use for thousands of years. Spices have also been recognized to possess several medicinal properties (Table 1) and have been effectively used in the indigenous systems of medicine in India and also in other countries (Nadkarni & Nadkarni, 1976). Apart from the traditional use, a host of beneficial physiological effects have been brought to the fore by extensive animal studies during the past three decades (Chandrasekhara & Srinivasan, 1999; Srinivasan, 2000, 2004a). Among these are their beneficial influence on lipid metabolism (Srinivasan, Sambaiah, & Chandrasekhara, 2004), efficacy as anti-diabetics (Srinivasan, 2004a, 2004b), ability to stimulate digestion (Platel & Srinivasan, 2004a), antioxidant property and anti-inflammatory potential. Investigations on the beneficial physiological influences of spices formed a thrust area of research persistently pursued for the past three decades at the Department of Biochemistry and Nutrition

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Table 1
Medicinal properties of a few spices

Spice	Medicinal property
Asafoetida (*Ferula asafoetida*)	Anti-bacterial, anti-spasmodic, diuretic, expectorant, laxative, useful in Angina pectoris, asthma
Cumin (*Cuminum cyminum*)	Anti-spasmodic, carminative, digestive stimulant
Fenugreek (*Trigonella foenumgraecum*)	Diuretic, emmenagogue, emollient, useful in heart diseases
Garlic (*Allium sativum*)	Anti-dyspeptic, anti-flatulent, useful for ear infection and duodenal ulcer, rubefacient in skin diseases
Ginger (*Zingiber officinale*)	Sialogogue, useful in diseases of heart and blood
Onion (*Allium cepa*)	Diuretic, emmenagogue, expectorant, useful for bleeding piles
Pepper (*Piper nigrum*)	Antipyretic, rubefacient
Red pepper (*Capsicum annuum*)	Anti-inflammatory, pain reliever (rheumatism and neuralgia), useful in indigestion, rubefacient
Turmeric (*Curcuma longa*)	Anti-inflammatory, diuretic, laxative, useful for diseases of liver, jaundice, diseases of blood

Source. Nadkarni and Nadkarni (1976).

of Central Food Technological Research Institute (CFTRI), Mysore. Establishing the safety of consumption of spices was a high priority research task in the initial years, when there was a fear of mutagenic potential of the active principles of turmeric and red pepper emanating from stray reports from the Western world. India happens to be the largest producer, consumer and exporter of spices. Naturally enough major research activities on spices have been carried out in laboratories of this country, and the most pioneering and large quantum of information have been generated from CFTRI. Important findings on diverse aspects of spices studied here (Table 2) are briefly reviewed in the following paragraphs.

2. Safety evaluation

In spite of the fact that spices have been extensively consumed for centuries, occasional doubts have been expressed regarding the safety of some of them. CFTRI played a major role in establishing the safety of turmeric (*Curcuma longa*) and its yellow colouring principle – curcumin as required by the WHO/FAO. Though not so extensively, limited safety evaluation study was also done on red pepper (*Capsicum annuum*) and black pepper (*Piper nigrum*). These studies indicated that even at several times normal human intake among Indian population (Thimmayamma, Rao, & Radhaiah, 1983), turmeric, red pepper, and black pepper have no adverse effects on growth, organ weights, Feed efficiency ratio, nitrogen balance, and blood chemistry (Bhat & Chandrasekhara, 1986a; Sambaiah, Ratankumar, Kamanna, Satyanarayana, & Rao, 1982; Srinivasan, Sambaiah, Satyanarayana, & Rao, 1980; Srinivasan & Satyanarayana, 1981). Debittered fenugreek (*Trigonella foenumgraecum*) was evidenced to be safe following acute exposure at 2 g/kg body weight in mice and 5 g/kg body weight in rats and at 10% level in the diet fed to growing rats in a cumulative toxicity study (Muralidhara, Narasimhamurthy, Viswanatha, & Ramesh, 1999). Employing reliable validated mammalian assays, it was conclusively demonstrated that neither capsaicin nor piperine induced any mutagenic effects in vivo either in the somatic or germ cells in mice (Muralidhara & Narasimhamurthy, 1988, 1990).

Table 2
Aspects of spices studied

(1) Safety of consumption
(2) Influence on lipid metabolism
(a) Fat absorption
(b) Hypotriglyceridemic and hypocholesterolemic activity
(c) Cholesterol turnover to bile acid
(3) Anti-lithogenic activity
(4) Anti-diabetic activity
(5) Antioxidant potential
(6) Anti-inflammatory activity
(7) Anti-mutagenic and anti-carcinogenic activity
(8) Digestive stimulant action
(9) Influence on platelet aggregation
(10) Protection of erythrocyte integrity
(11) Metabolic disposition of active principles
(12) Availability of spice principles from heat processed spices

3. Hypolipidemic influence

One of the pioneering observations is the influence of spices on lipid metabolism (Tables 3–5), especially demonstration of the hypolipidemic and hypocholesterolemic activities of turmeric and its yellow principle – curcumin, red pepper and its pungent principle – capsaicin, and of garlic. Turmeric and red pepper and their active principles – curcumin and capsaicin were found to be effective as hypocholesterolemic agents under various conditions of experimentally induced hypercholesterolemia/hyperlipemia in rats (Bhuvaneswaran et al., 1963; Bhuvaneswaran, Sriramachari, Jayaraj, Srinivasan, & Subramanyan, 1963; Kempaiah & Srinivasan, 2002; Patil & Srinivasan, 1971; Sambaiah & Satyanarayana, 1980; Srinivasan et al., 1964; Subba Rao, Chandrasekhara, Satyanarayana, & Srinivasan, 1970). Beneficial hypolipidemic effect of dietary curcumin was also seen in experimentally induced hypertriglyceridemic rats