

A Comprehensive Review on *Rasam*: A South Indian Traditional Functional Food

Agilandeswari Devarajan^{1,2}, M. K. Mohanmarugaraja²

¹Department of Pharmaceutics, Hillside College of Pharmacy and Research Centre, Bengaluru, Karnataka, ²Department of Pharmacy, Centre for Research and Development, PRIST University, Thanjavur, Tamil Nadu, India

ABSTRACT

The view that food can have an expanded role that goes well beyond providing a source of nutrients truly applies to traditional functional foods. The systematic consumption of such traditional functional food provides an excellent preventive measure to ward off many diseases. *Rasam*, a soup of spices, is a traditional South Indian food. It is traditionally prepared using tamarind juice as a base, with the addition of Indian sesame oil, turmeric, tomato, chili pepper, pepper, garlic, cumin, curry leaves, mustard, coriander, asafoetida, sea salt, and water. *Rasam* is a classic example of traditional functional food with all its ingredients medicinally claimed for various ailments. The preclinical and clinical studies on *rasam* and its ingredients support their traditional claim. This review is an attempt to compile the literatures on *rasam*, its ingredients, and to highlight its medicinal potential that has been underestimated.

Key words: Asafoetida, black pepper, garlic, preventive medicine, spice soup, turmeric

INTRODUCTION

Food is consumed in combinations, in relatively large, unmeasured quantities under highly socialized conditions. The view that food can have an expanded role that goes well beyond providing a source of nutrients truly applies to traditional functional foods. The systematic consumption of such traditional functional food provides an excellent preventive measure to ward off many diseases. At present, recommendations are warranted to support the consumption of foods rich in bio-active components, such as herbs and spices.^[1] There is a tremendous interest and research in the health-promoting and protective properties of herbs and spices.^[2] The real challenge lies not in proving whether the functional foods have health benefits, but in defining what these benefits are and developing the methods to expose them by scientific means. Also, it lies in investigating the bioactive properties of these functional foods beyond a nutritional context, whether or not such properties are evident at levels at which herbs and spices are consumed.^[3] It is estimated that an adult in India consumes 80–200 mg/day of curcumin, the bioactive component of turmeric, and 50 g of garlic in a week.^[1,4] Hence, there is a realistic possibility to reach a therapeutic dose by daily dietary consumption.

The current approach of drug discovery in phytopharmaceuticals is based on the so-called “one-molecule-one-target” paradigm due to the historical effects of morphine, quinine, digoxin, etc. Essentially, there

need not be only a single active constituent for all the traditionally claimed herbs and spices. Each of them may possess >1 bioactive compound; there is also a possibility of synergy among them in their action. Recent researches have confirmed that the therapeutic effect may also be due to the synergistic effects of various constituents. Moreover, due to the multifactorial pathogenesis of the disease, drugs that hit >1 biological target may offer a better pharmacological approach by providing;^[5]

1. Synergistic multi-target effect
2. Pharmacokinetic or physicochemical effects based on improved solubility, resorption rate, and enhanced bioavailability of one constituent over another, and
3. Respective elimination or neutralization of adverse effects of one constituent by the other contained in the food so that altogether a better effectiveness is achieved.

There is a need to understand traditional systems and visualize the future of medicine and health care. The linkage between “the past” and “the future” of medicine is much more important and can give us “new directions” for better understanding of health, disease, and possible solutions.^[6] *Rasam*, a soup of spices, is a traditional South Indian food. This review is an attempt to compile the literatures on *rasam*, its ingredients, and to highlight its medicinal potential that has been underestimated.

TRADITIONAL FUNCTIONAL FOOD

Functional foods in the postmodern terms are defined as a food given an additional function (often one related to health promotion or disease prevention) by adding new ingredients or more of the existing ingredients.^[7] Grajek *et al.*, 2005,^[8] states that functional foods comprise some bacterial strains and products of plant and animal origin containing

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

Cite this article as: Devarajan A, Mohanmarugaraja MK. A comprehensive review on *Rasam*: A South Indian traditional functional food. *Phcog Rev* 2017;11:73-82.

Correspondence:

Prof. Agilandeswari Devarajan,
Department of Pharmaceutics, Hillside College of Pharmacy and Research
Centre, #9, Raghuvanahalli, Kanakapura Main Road,
Bengaluru - 560 062, Karnataka, India.
E-mail: agilandeswaridevarajan@gmail.com

Access this article online

Quick Response Code:



Website:

www.phcogrev.com

DOI:

10.4103/phrev.phrev_13_17

physiologically active compounds beneficial for human health and reducing the risk of chronic diseases. The functional ingredients are as follows;

1. Probiotics and prebiotics
2. Dietary fiber
3. Omega-3-poly unsaturated fatty acids
4. Conjugated linoleic acid
5. Plant antioxidants
6. Vitamins and minerals
7. Some proteins, peptides, and amino acids
8. Phospholipids.

Foods introduced with a new ingredient^[7] or a bacterial strain or containing the functional ingredients^[8] may be a definition of functional foods but they are certainly not traditional functional foods. In fact, traditional functional foods are absolutely not medicines but usual diet that may have special disease prevention attributes and consumed as normal everyday diet. An ingredient of food that affects its host in a targeted manner to exert positive effect on health can be classified as a functional ingredient. A traditional food that naturally comprises one or more functional ingredients can be referred as traditional functional food.

INDIAN TRADITIONAL FUNCTIONAL FOOD

Our ancestors originally created different diets to survive after which they gradually enriched them through long empirical experiments using locally available food materials that therapeutically complement and supplement each other. The traditional food habits of each specific region of India are primarily a component of its culture. Indian culture has strongly suggested the role of diet in both preventive and therapeutic medicines. The curative effect of food is an established belief for many generations in India. These Indian traditional foods are based on the different indigenous systems of medicine which was the natural way of achieving physical and mental wellness, but their origin still remains unknown.

Epidemiological randomized clinical trials carried out in different countries have demonstrated numerous health effects related to functional food consumption such as reduction of cancer risk, improvement of heart health, stimulation of immune system, decrease of menopausal symptoms, improvement of gastrointestinal health, maintenance of urinary tract health, anti-inflammatory effects, reduction of blood pressure, maintenance of vision, antibacterial effect, antiviral effect, reduction of osteoporosis, and anti-obese effect.^[9] It has been reported that the occurrence of cardiovascular diseases, metabolic diseases, neurodegenerative diseases, and cancer in Indian adults was indeed 4.4 times less than the same age group in the USA. The whole world realized that food plays a major role in disease prevention only in the 20th century, but ancient India seems to have realized the importance of food in health and wellness much ahead of time.

The functional ingredients in food play a key role in imparting beneficial physiological effects for improved health. The traditional Indian food is “functional” as it contains high amounts of dietary fiber (whole grains and vegetables), antioxidants (spices, fruits, and vegetables), and probiotics (curds and fermented batter products). Due to the chemical diversification of the ingredients, these Indian traditional foods exhibit synergistic effect. Indian traditional foods which are mainly based on plant products are very rich in natural dietary fiber and low fat which naturally reduce the risk of coronary heart disease. The health benefits thus derived may range from ensuring normal physiological functions in the body such as

improving gastrointestinal health, enhancing the immune system, weight management, providing better skeletal health, reduction of blood cholesterol, decreasing oxidative stress, minimizing the risk of cardiovascular and neurodegenerative diseases, and also possible prevention of diabetes.^[10]

SPICES IN SOUTH INDIAN TRADITIONAL FUNCTIONAL FOOD

Traditional South Indian foods provide a perfect combination of proteins from legumes and coconut, carbohydrates from rice, fats both visible and invisible from curry and fried savory items, vitamins and minerals from sprouted grams, and vegetables which contain functional components such as β-carotene, Vitamins C and E, thiamine, tocopherol, and antioxidant compounds [Figure 1].^[10]

Spices play very important role in digestive function, and the Indian tradition has a long history of use of spice in food as medicines to prevent and treat diseases.^[11] In the recent years, the scientific community has taken interest in understanding the values of traditionally used Indian spices because of their wide array of medicinal properties. Spices, which are used to enhance the flavor of a dish, form a vital part of South Indian traditional food preparation. The most commonly used spices in South Indian traditional foods are black pepper, coriander, black mustard, cumin, garlic, tamarind, turmeric, chili pepper, curry leaves, asafoetida, etc. Most of these spices are digestive stimulants; other uses are as mentioned below [Figure 2];

1. Turmeric, asafoetida, and garlic have antimicrobial activities
2. Fenugreek, garlic, onion, and turmeric have antidiabetic activities
3. Garlic, onion, fenugreek, turmeric, and chili pepper have cholesterol-lowering activities
4. Turmeric, garlic, onion, chili pepper, and fenugreek have anti-lithogenic activities
5. Turmeric, garlic, and ginger have anticancer activities
6. Turmeric, clove, garlic, onion, and chili pepper have antioxidant activities
7. Turmeric, chili pepper, and garlic have anti-inflammatory activities.

The credit for identifying the spices with medicinal and culinary values goes to *Siddha* and *Ayurveda* system of Indian medicines. The South Indian traditional foods are based on *Siddha* system of medicine, which in natural way aims in achieving physical and mental wellness.

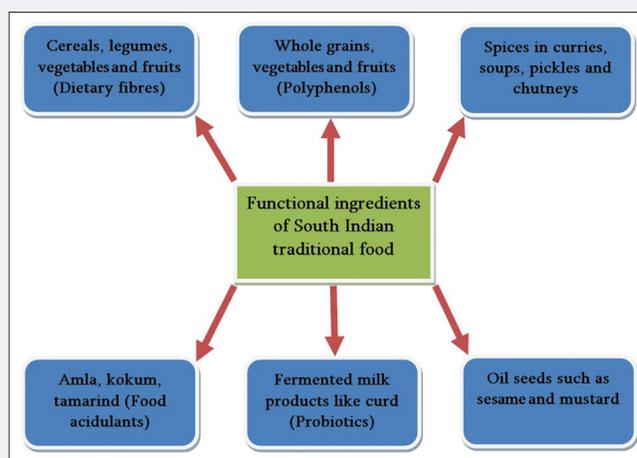


Figure 1: Functional ingredients of South Indian traditional food

ROLE OF SIDDHA SYSTEM OF MEDICINE IN SOUTH INDIAN TRADITIONAL FUNCTIONAL FOOD

Siddha, a system of traditional medicine, originated in ancient *Thamilakam* in South India.^[12] The *Siddha* system is based on a combination of ancient medicinal practices and spiritual disciplines as well as alchemy and mysticism. Its origin goes back to 10,000–4000 BCE.

“*Unavae marunthu*” (meaning “food is medicine”) is a classical and extraordinary discovery of *Siddha* system of medicine. In the modern literatures, the same quote “Let food be thy medicine and medicine be thy food” is attributed to Hippocrates. However, the concept of “*Unavae marunthu*” is at least 3500 years before Hippocrates (460–370 BCE). Currently, the same old concept of “*Unavae marunthu*” is re-researched as functional foods. The postmodern “preventive medicine” concept of the Western medicine has absolutely recognized that food plays an important role in the incidence of many diseases. Dietary choice remains the basis for maintaining a healthy lifestyle and well-being, especially relating to cardiovascular disease, diabetes, obesity, hypertension, some cancers, circulatory diseases, and stroke, despite remarkable advances in medicine and pharmaceutical drug development.^[13,14]

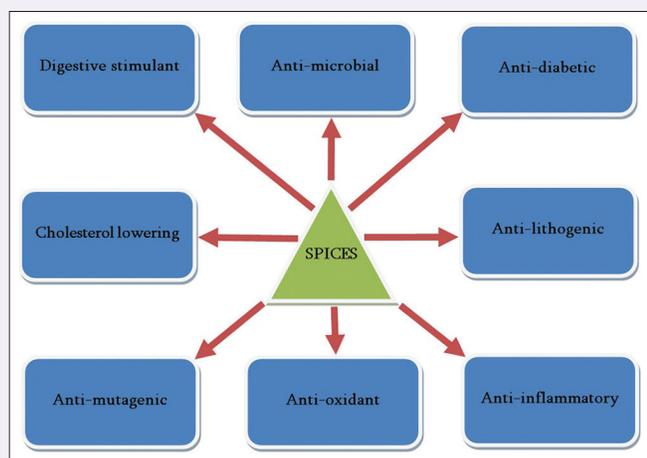


Figure 2: Summary of the multiple health effects of spices used in South Indian traditional food

Rasam

Rasam is a very popular South Indian traditional soup. It is consumed on a daily basis in every South Indian home. It is also called *rasam* or *chaaru* or *saaru* in South Indian languages, namely, Tamil, Malayalam, Telugu, and Kannada. In Sanskrit, *rasam* means “the essential products of digestion.”^[15] South Indian traditional food, which is largely nongreasy, consists of cooked rice usually served with *sambar*, *rasam*, dry and/or curried vegetables, and curd. *Rasam* is mostly eaten with rice and rarely separate as a spicy soup. In a traditional South Indian meal, it is preceded by a *sambar* rice course and is followed by curd rice. *Rasam* is traditionally prepared using tamarind juice as a base, with a variety of spices which are considered to be good for health and improving the digestion.^[16] The strong blended flavor of spices used in *rasam* preparation makes it unique in taste and flavor. The main spices used in *rasam* preparation are coriander, garlic, curry leaves, tamarind, cumin, black pepper, mustard, turmeric, red chili, and asafoetida.^[17] *Rasam* is the spiciest soup and the thick orange liquid delivers layers of flavor that nourish and heal.^[18] South Indian meals with *rasam* show higher moisture and nutrient content compared to Maharashtrian meals.^[19]

Rasam can be regarded as a classic example of an ideal recipe subscribing to the principles laid by Indian system of medicines such as *Ayurveda* and *Siddha* [Table 1].^[11] It is traditionally prepared using tamarind juice as a base, with the addition of various spices [Table 2]. *Rasam* is used as an appetizer,^[20] and there are different types of *rasam* based on the permutation and combination of its constituent spices.^[21] Some types of *rasam* are listed with its main ingredients prepared in Tamil Nadu [Table 3].^[22,23]

Antipyretic activity

In South India, *rasam* is considered an effective home remedy for cold.^[24] Sanmugam and Kasinathan, 2011, have reported that *rasam* can be used as an antidote for flu or fever.^[25] Tribal families of Krishnagiri district, Tamil Nadu, consume *rasam* for the treatment of fever, common cold, and diarrhea.^[26] Devi and Priyadarshini, 2014, have reported that *rasam* is traditionally used for the treatment of cold, cough, and diabetes.^[27]

Hypoglycemic activity

Mani *et al.*, 1997, have reported that the glycemic index and the triacylglycerol response in ninety normal volunteers after South Indian meals with *rasam* significantly controlled diabetes.^[28] Banerjee, 2004, has reported that green pea and tomato *rasam* play a major role in controlling diabetes.^[29] Bolla *et al.*, 2015, have reported that South Indian diet with

Table 1: Properties, explanation, and the significance of *rasam*

Properties	Explanation	Significance of <i>rasam</i>
Taste	Taste is very essential for proper consumption and digestion	Provides it very effectively
Liquidity	The food should be liquid ensuring good digestion and not to be solid or hard	It is very watery in nature
Consumption	The food should be such that even when consumed in large quantity should sustain normalcy	It is time tested to advocate for regular consumption
Lightness	Easily digestible	It not only gets digested easily but also helps digestion of other food substances. This is a major criterion to consider any food substance as conducive. <i>Rasam</i> undoubtedly contains this property in the best possible way
Compatibility	The ingredients in any food recipe should contain mutually acceptable and synergistically compatible qualities and never contradictory to each other	In <i>rasam</i> , none of the ingredients possess contradictory properties and minor if any will be taken care with balancing material like asafoetida
Nourishment (pleasant and sweet)	Pleasant and sweetness are essential for the well-being of both mind and body. Excellent sense of pleasure of eating will be produced	<i>Rasam</i> with rice together produces both these qualities simultaneously
Blended taste	An ideal food should be a recipe of six blended tastes (sweet, pungent, astringent, bitter, sour, and salt)	The rice provides sweetness and the spice provides pungent, astringent, bitter, sour, and salt tastes

Table 2: Biological source of the ingredients and its quantity used in the preparation of *rasam*

Common names	Morphological part used	Nature of the material	Botanical name	Family
Tamarind	Ripped fruit pulp	Dried	<i>Tamarindus indica</i> L.	Fabaceae
Turmeric	Rhizome powder	Dried	<i>Curcuma longa</i> L.	Zingiberaceae
Sea salt	NA	Solid	NA	NA
Tomato	Ripped fruit	Fresh	<i>Solanum lycopersicum</i> L.	Solanaceae
Chili pepper	Crushed fruit of long chili pepper	Dried	<i>Capsicum annum</i> L.	Solanaceae
Cumin	Ripped fruit	Dried	<i>Cuminum cyminum</i> L.	Apiaceae
Garlic	Cloves	Dried	<i>Allium sativum</i> L.	Amaryllidaceae
Black pepper	Unripe drupe	Dried	<i>Piper nigrum</i> L.	Piperaceae
Indian sesame oil	Seed	Oil	<i>Sesamum indicum</i> L.	Pedaliaceae
Black mustard	Seed	Dried	<i>Brassica nigra</i> L.	Brassicaceae
Chili pepper	Whole fruit of long chili pepper	Dried	<i>Capsicum annum</i> L.	Solanaceae
Curry leaves	Leaves	Fresh	<i>Murraya koenigii</i> (L.) Sprengel	Rutaceae
Portable water	NA	Liquid	NA	NA
Coriander	Leaves	Fresh	<i>Coriandrum sativum</i> L.	Apiaceae
Asafoetida	Dried latex (oleo-gum resin) exuded from the rhizome or tap root	Powder	<i>Ferula assa-foetida</i> L.	Apiaceae

NA=Not available

Table 3: Different types of *rasam* prepared in Tamil Nadu

Types of <i>rasam</i>	Main ingredient
<i>Koli rasam</i>	Sieving water from chicken
<i>Kadalai rasam</i>	Black chick peas
<i>Venkaaya rasam</i>	Onion
<i>Thakkaali rasam</i>	Tomato
<i>Poondur rasam</i>	Garlic
<i>Inji rasam</i>	Ginger
<i>Maangaa rasam</i>	Raw mango
<i>Elumichai rasam</i>	Lemon juice
<i>Nellikai rasam</i>	Indian gooseberry
<i>Murungai poo rasam</i>	Drumstick flower
<i>Mudakathaana rasam</i>	Balloon vine
<i>Vepam poo rasam</i>	Neem flower
<i>Kandathippili rasam</i>	Greens
<i>Tili rasam</i>	Sieving water from plain rice
<i>Milagu rasam</i>	Black pepper
<i>Jeeraga rasam</i>	Cumin
<i>Puli rasam</i>	Tamarind extract
<i>Parupu rasam</i>	Pulses
<i>Kollu rasam</i>	Horse gram

rasam everyday showed a significant reduction in the blood sugar levels of forty volunteers between 30 and 60 years.^[30]

Treatment of anemia

Rani and Paulraj, 2013, have reported that blood iron profile – hemoglobin, serum iron, transferrin saturation, serum ferritin, total iron-binding capacity, and unsaturated iron-binding capacity – in anemic patients was greatly influenced by dietary intervention with the functional food Spirulina incorporated in *rasam*.^[31] Mamatha and Prakash, 2016, have reported that >70% of iron was bio-accessible, in comparison to 30%–37% in controls when iron-fortified tamarind-based *rasam* was administered.^[32] Salau and Hasan, 2014, have studied major and trace elements in *rasam* and reported that *rasam* can be exploited for health maintenance, remedy, and even cure for mineral deficiency diseases.^[33]

For better lactation

Rajan *et al.*, 2001, have reported that *rasam* is given daily in the evening to nursing mothers for inducing more secretion of milk.^[34] Rao *et al.*, 2006, have reported that *rasam* is one of the daily preferred food items during pregnancy and after delivery among the tribals of north coastal Andhra Pradesh.^[35]

Antimicrobial activity

A significant antimicrobial activity of *rasam* against *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, *Klebsiella Pneumoniae*, and *Escherichia coli* has been reported.^[36]

Laxative

Swapna, 2015, has reported that Yanadi tribe of Kavali, Andhra Pradesh, use *rasam* as a laxative.^[37]

General health improvement

Priyadharshini and Sowmya, 2012, have reported that there was a significant improvement in the performance level of female football players after the administration of the pregame meal for lunch with *rasam* every day for a week.^[38] Nayak and Shalini, 2013, have reported that a 10-year-old female child suffering from chicken pox recovered after 21 days by providing only traditional food along with horse gram *rasam*.^[39] Suri *et al.*, 2006, have reported that cheap high-calorie diet like *rasam* can be consumed to manage major burns and also to decrease morbidity.^[40]

INGREDIENTS OF RASAM

Tamarind

Tamarind fruit pulp is edible and is known to be simultaneously the most acidic and sweetest fruit. The sweet acidic taste is due to a combination of high contents of tartaric acid and reducing sugars. According to the World Health Organization report, tamarind fruit is an ideal source of all essential amino acids except tryptophan.^[41] The fruit pulp is used for seasoning, as a food component, to flavor confections, curries, and sauces, and is a main component in juices and certain beverages.^[42]

Throughout Southeast Asia, the fruit of the tamarind is used as a poultice applied to foreheads of fever sufferers.^[43] Tamarind fruit exhibits laxative effects due to its high quantities of malic acid, tartaric acid, and potassium bitartrate. Its use for the relief of constipation has been documented throughout the world including Thailand, Southwest Africa, and Madagascar.^[44,45] Parthasarathy *et al.*, 2008, and De Caluwe *et al.*, 2010, have reported that tamarind fruit pulp has digestive, hepatic tonic, anti-inflammatory, corneal wound healing, antioxidant, and moluscicidal properties.^[24,46] The fruit pulp contains 44.4% of furan derivatives and 38.3% of carboxylic acid derivatives such as tartaric acid, acetic acid, citric acid, formic acid, malic acid, and succinic acid.^[47-49] It also shows the presence of high amounts of ascorbic acid, β -carotene,

lactic acid, Vitamin B1, B3, amino acids, invert sugar (25%–30%), pectin, pyrazines, and some fragrant thiazoles.^[50-52] The fruit pulp also contains alkaloids, glycosides, saponins, sesquiterpenes, flavonoids, tannins, and phlobatannins.^[48,53] Nutritional content of tamarind fruit pulp per 120 g is mentioned in Table 4.^[54,55]

Turmeric

Turmeric is one of the key ingredients in many Asian dishes. The Indian traditional medicine, *Siddha*, has recommended turmeric for medicine. Turmeric has been used as an attempted treatment for a variety of internal disorders, such as indigestion, throat infections, common colds, or liver ailments, as well as topically to cleanse wounds or treat skin sores^[56] Itokawa *et al.*, 2008, and Parthasarathy *et al.*, 2008, have reported that turmeric possesses antioxidant, hepatoprotective, anti-inflammatory, anticarcinogenic, and antimicrobial properties, in addition to its use in cardiovascular disease, antidiabetic, antiangiogenic effect, antithrombotic effect, hepatoprotective effect, and gastrointestinal disorders.^[24,57]

Ground turmeric is a powder obtained by disc-type attrition mills to obtain 60–80 mesh powder for use in various end products. The most important chemical components of turmeric are a group of compounds called curcuminoids, which include curcumin (diferuloylmethane), demethoxycurcumin, and bisdemethoxycurcumin. The best-studied compound is curcumin, which constitutes 3.14% (on average) of powdered turmeric.^[58] In addition, other important volatile oils include turmerone, atlantone, and zingiberene. Some general constituents are sugars, proteins, and resins.^[59] Nutritional content of turmeric powder per 100 g is mentioned in Table 4.^[60]

Tomato

Tomato contains β -carotene, a member of the carotenes, which are terpenoids (isoprenoids) and lycopene, a bright red carotene pigment. Druesne-Pecollo *et al.*, 2010, have concluded that supplementation with β -carotene does not appear to decrease the risk of neither cancers overall nor specific cancers including pancreatic, colorectal, prostate, breast, melanoma, or skin cancer generally.^[61] Moreover, β -carotene is unstable in cigarette smoke-exposed lungs where it forms oxidized metabolites that can induce carcinogen-bioactivating enzymes.^[62] Hence, medical authorities generally recommend obtaining β -carotene from food like tomato rather than dietary supplements.^[63] Lycopene as dietary supplement or from tomatoes has been tested in humans for cardiovascular diseases and cancer. However, there is no conclusive evidence to conclude that lycopene had an effect on any disease.^[64-66] Nutritional content of tomato per 100 g is mentioned in Table 4.^[67]

Chili pepper

The Aztecs used chili pungency to relieve toothache. Chili peppers have also exhibited antioxidant, anticancer, and aflatoxigenic activities.^[24] Capsaicin, an active component of chili peppers, is used as an analgesic in topical ointments, nasal sprays, and dermal patches to relieve pain typically in concentrations between 0.025% and 0.1%. It may be applied in cream form for the temporary relief of minor aches and pains of muscles and joints associated with arthritis, backache, strains, and sprains, and often in compounds with other rubefaciants. It is also used to reduce the symptoms of peripheral neuropathy such as postherpetic neuralgia caused by shingles.^[68] The color of chili spice powder is due to the presence of red-pigmented carotenoids. The main pigments are capsanthin, capsorubin,

Table 4: Nutritional values of tamarind, turmeric, and tomato

Contents	Per 120 g of tamarind fruit pulp	Per 100 g of turmeric powder	Per 100 g of tomato fruit	Units
Water	37.68	12.85	94.52	g
Energy	287	312	18	kcal
Protein	3.36	9.68	0.88	g
Total lipid (fat)	0.72	3.25	0.2	g
Ash	3.24	1.32	0.5	g
Carbohydrate	75	67.14	3.89	g
Fiber, total dietary	6.1	22.7	1.2	g
Sugars, total	46.56	3.21	3.62	g
Minerals				
Calcium	89	168	10	mg
Iron	3.36	55	0.27	mg
Magnesium	110	208	11	mg
Phosphorus	136	299	24	mg
Potassium	754	2080	237	mg
Sodium	34	27	5	mg
Zinc	0.12	4.5	0.17	mg
Copper	0.103	-	0.059	mg
Vitamins				
Vitamin C, total ascorbic acid	4.2	0.7	13.7	mg
Thiamin	0.514	0.058	0.037	mg
Riboflavin	0.182	0.15	0.019	mg
Niacin	2.326	1.35	0.594	mg
Pantothenic acid	0.172	-	0.089	mg
Vitamin B-6	0.079	0.107	0.08	mg
Folate, total	17	-	15	μ g
Vitamin A, IU	36	-	833	IU
Vitamin E (alpha-tocopherol)	0.12	4.43	0.54	mg
Vitamin K (phylloquinone)	3.4	13.4	7.9	μ g
Lipids				
Fatty acids, total saturated	0.326	1.838	0.028	g
Fatty acids, total monounsaturated	0.217	0.449	0.031	g
Fatty acids, total polyunsaturated	0.071	0.756	0.083	g

zeaxanthin, and cryptoxanthin. Nutritional content of chili peppers per 100 g is mentioned in Table 5.^[69]

Cumin

Cumin is used in the cuisines of many different cultures, in both whole and ground forms. It is used as a spice for its distinctive flavor and aroma. It is used mainly as a seasoning in curry powders, soups, stews, sausages, cheeses, pickles, meats, and chutneys.^[70] In the *Siddha* system of medicine, dried cumin seeds are believed to have medicinal purposes, it is used internally and sometimes for external applications also. In South Indian states, such as Kerala and Tamil Nadu, a popular drink called *jeera* water is made by boiling cumin seeds. It is used as a stimulant, an antispasmodic, and a carminative. Cumin seeds are widely used for the treatment of dyspepsia, diarrhea, and jaundice.^[71] Dietary cumin seeds have showed marked hypoglycemic response in diabetic rats.^[72] Parthasarathy *et al.*, 2008, have reported that cumin has myriad physiological effects, such as hypoglycemic, hypolipidemic, iron source, chemoprotective, antimicrobial, antioxidant, and tyrosinase inhibitor activities.^[24] Cumin's distinctive flavor is due to its essential oil content. Cuminaldehyde, cymene, cuminic alcohol, and terpenoids are the major volatile components of cumin.^[73] Nutritional content of cumin fruit per 100 g is mentioned in Table 5.^[74]

Garlic

The garlic bulb is normally divided into numerous fleshy sections called cloves. Garlic cloves are used for consumption (raw or cooked) and/or for medicinal purposes. They have a characteristic pungent, spicy flavor that mellows and sweetens considerably with cooking. Fresh or crushed garlic yields the sulfur-containing compounds such as alliin, ajoene, diallyl polysulfides, vinylidithiins, and S-allylcysteine. When fresh garlic

is chopped or crushed, the enzyme alliinase converts alliin into allicin, which is responsible for the aroma of fresh garlic.

Alliin is part of a defense mechanism against attacks by pests on the garlic plant.^[75] The allicin generated is unstable and quickly changes into a series of other sulfur-containing compounds such as diallyl disulfide. They also contain saponins, flavonoids, and Maillard reaction products, which are not sulfur-containing compounds.

Garlic was used as an antiseptic to prevent gangrene during World Wars I and II. Garlic reduces platelet aggregation, hence people taking anticoagulant medication are cautioned about consuming garlic.^[76] In a clinical trial, a daily high dose of extracted allicin (20 times the amount in a garlic clove) showed effectiveness to prevent the common cold.^[77] Iyer *et al.*, 2009, and Banerjee *et al.*, 2002, have reported that garlic bulbs decrease blood pressure, glucose concentration, and the risk of atherosclerosis.^[78,79] They have also reported the bulbs for antimicrobial, anticancer, hepatoprotective, and antioxidant effects. Ajoene is an organo-sulfur compound found in garlic, which blocks the integrin-dependent processes in the infected cell system of a human immunodeficiency virus.^[80] Ajoene has been investigated as an antileukemia agent for acute myeloid leukemia therapy.^[81-83] Nutritional content of garlic bulb per 100 g is mentioned in Table 5.^[84]

Black pepper

Various sources from the 5th CE onward recommended black pepper to treat eye problems, often by applying salves or poultices made with pepper directly to the eye. However, there is no current medical evidence that any of these treatments has any benefit. Black pepper cures several illnesses, such as constipation, insomnia, oral abscesses, sunburn, and toothaches. It is an important healthy food owing to its

Table 5: Nutritional values of chili pepper, cumin, and garlic

Contents	Per 100 g of chili pepper	Per 100 g of cumin fruit	Per 100 g of garlic bulb	Units
Water	88.02	8.06	58.58	g
Energy	40	375	149	kcal
Protein	1.87	17.81	6.36	g
Total lipid (fat)	0.44	22.27	0.5	g
Carbohydrate	8.81	44.24	33.06	g
Fiber, total dietary	1.5	10.5	2.1	g
Sugars, total	5.3	2.25	1	g
Minerals				
Calcium	14	931	181	mg
Iron	1.03	66.36	1.7	mg
Magnesium	23	366	25	mg
Phosphorus	43	499	153	mg
Potassium	322	1788	401	mg
Sodium	9	168	17	mg
Zinc	0.26	4.8	1.16	mg
Vitamins				
Vitamin C, total ascorbic acid	143.7	7.7	31.2	mg
Thiamin	0.072	0.628	0.2	mg
Riboflavin	0.086	0.327	0.11	mg
Niacin	1.244	4.579	0.7	mg
Vitamin B-6	0.506	0.435	1.235	mg
Folate (DFE)	23	10	3	µg
Vitamin A (RAE)	48	64		µg
Vitamin A (IU)	952	1270	9	IU
Vitamin E (alpha-tocopherol)	0.69	3.33	0.08	mg
Vitamin K (phylloquinone)	14	5.4	1.7	µg
Lipids				
Fatty acids, total saturated	0.042	1.535	0.089	g
Fatty acids, total monounsaturated	0.024	14.04	0.011	g
Fatty acids, total polyunsaturated	0.239	3.279	0.249	g

RAE=Retinol activity equivalent, DFE=Dietary folate equivalent

antioxidant, anti-obesity, gastroprotective, anticancer, and antimicrobial potential.^[85] As a natural medicinal agent, black pepper has been credited for relieving arthritis, nausea, fever, migraine headaches, poor digestion, strep throat, and even coma.^[86-88] It has also been used in some forms of traditional medicine as an insecticide.^[24] Piperine is under study for a variety of possible physiological effects,^[89] although this work is preliminary, and mechanisms of activity for piperine in the human body remain unknown. Piperine increases the absorption of selenium, Vitamin B12, β -carotene, and curcumin, as well as other compounds. Piperine is shown to possess bioavailability-enhancing activity with various structurally and therapeutically diverse drugs.^[90] Black pepper contains piperine between 4.6% and 9.7%. Piperine, along with its isomer chavicine, is the alkaloid responsible for the pungency of black pepper. It also contains amides, piperidines, pyrrolidines, and trace amounts of safrole.^[91] Nutritional content of black pepper drupe per 100 g is mentioned in Table 6.^[92,93]

Indian sesame oil

Sesame oil is an edible vegetable oil derived from sesame seeds. There are many variations in the color of sesame oil: cold-pressed sesame oil is pale yellow, while Indian sesame oil (gingelly or til oil) is golden and East Asian sesame oils are commonly dark brown. This dark color and flavor are derived from roasted/toasted sesame seeds. Cold-pressed sesame oil has a different flavor than the toasted oil, since it is produced directly from raw, rather than toasted, seeds. In *Ayurveda* and *Siddha* systems of medicine, sesame oil (til oil) is used for massaging as it is believed to rid the body's heat due to its viscous nature upon rubbing. It is used for hair and scalp massage. It is also used in many cosmetic applications, including as carrier oil.^[94] Sesame oil is composed of the following fatty

acids: linoleic acid (41% of total), oleic acid (39%), palmitic acid (8%), stearic acid (5%), and others in small amounts.^[95]

Black mustard

Black mustard has shown hypoglycemic effect in rats,^[96] and its mucilage has improved postprandial glucose concentrations and insulinemia in rats.^[97] Nutritional content of black mustard seed per 100 g is mentioned in Table 6.^[98]

Curry leaves

These leaves are used in many dishes in India, Sri Lanka, and neighboring countries, often used in curries for flavor, hence these leaves are generally called by the name "curry leaves."^[99] They are aromatic, slightly bitter, acrid, cooling, and weakly acidic in taste. Leaves are also used in treating scabies, wounds, hypertension, pimples, rashes, itching, constipation, liver disorders, and weight loss. The leaves stimulate digestive enzymes and are a good remedy for nausea and indigestion. The leaves are also good for hair growth and color.^[100] Curry leaves have been reported for hepatoprotective, antimicrobial, anti-inflammatory, cardioprotective, and antipyretic activities.^[96,101] Traditionally, the leaves are advocated for diabetes. Feeding the leaves to rats produced hypoglycemia by increasing the hepatic glycogenesis as evident by an increased activity of glycogen synthetase.^[96,101] Sujatha and Srinivas, 1995, have reported that adding fresh curry leaves in the diet of Albino rats showed an alteration in peroxidation level to a beneficial extent.^[102] Shah and Juvekar, 2010, have reported that oral administration of the aqueous extract of curry leaves at doses of 250 and 500 mg/kg significantly enhanced the delayed-type hypersensitivity reaction induced by ovalbumin.^[103]

Table 6: Nutritional values of black pepper, black mustard, and coriander

Contents	Per 100 g of black pepper drupe	Per 100 g of black mustard seed	Per 100 g of coriander leaves	Units
Water	12.46	5.27	92.21	g
Energy	251	508	23	kcal
Protein	10.39	26.08	2.13	g
Total lipid (fat)	3.26	36.24	0.52	g
Carbohydrate	63.95	28.09	3.67	g
Fiber, total dietary	25.3	12.2	2.8	g
Sugars, total	0.64	6.79	0.87	g
Minerals				
Calcium	443	266	67	mg
Iron	9.71	9.21	1.77	mg
Magnesium	171	370	26	mg
Phosphorus	158	828	48	mg
Potassium	1329	738	521	mg
Sodium	20	13	46	mg
Zinc	1.19	6.08	0.5	mg
Vitamins				
Vitamin C, total ascorbic acid	-	7.1	27	mg
Thiamin	0.108	0.805	0.067	mg
Riboflavin	0.18	0.261	0.162	mg
Niacin	1.143	4.733	1.114	mg
Pantothenic acid	-	-	0.57	mg
Vitamin B-6	0.291	0.397	0.149	mg
Folate (DFE)	17	162	62	μ g
Vitamin A (RAE)	27	2	337	μ g
Vitamin A (IU)	547	31	6748	IU
Vitamin E (alpha-tocopherol)	1.04	5.07	2.5	mg
Vitamin K (phylloquinone)	163.7	5.4	310	μ g
Lipids				
Fatty acids, total saturated	1.392	1.989	0.014	g
Fatty acids, total monounsaturated	0.739	22.518	0.275	g
Fatty acids, total polyunsaturated	0.998	10.088	0.04	g

RAE=Retinol activity equivalent, DFE=Dietary folate equivalent

Alkaloids are found in curry leaves, stems, and seeds which include mahanimbine, girinimbine, koenimbine, and mahanine. Numerous carbazole alkaloids have also been reported from leaves. Leaves also contain lutein, α -tocopherol, and carotene.^[101] Mature leaves contain 63.2% moisture, 1.15% total nitrogen, 6.15% fat, 18.92% total sugars, 14.6% starch, 6.8% crude fiber, 13.06% ash, 1.35% acid-insoluble ash, 1.82% alcohol-soluble extractive, 27.33% cold water (20°C) extractive, and a maximum of hot water-soluble extractive 33.45%.^[104] The leaf extract of curry leaves has been reported to contain moisture (66.3%), protein (1%), fat (1%), carbohydrate (16%), fiber (6.4%), and mineral matter (4.2%). The main minerals per 100 g of leaves are calcium (810 mg), phosphorus (600 mg), and iron (2.1 mg). The vitamins in the leaves are carotene (12,600 IU), nicotinic acid (2.3 mg), and Vitamin C (4 mg). The extract also contains oxalic acid, which also reduces the availability of calcium. They also contain total oxalate (1.352%) and soluble oxalate (1.155%). More importantly, nearly zero fat (0.1 g/100 g) is found in curry leaves.^[24]

Coriander leaves

Fresh leaves are traditionally used in cooking throughout the world. Chopped coriander leaves are a garnish on many Indian dishes. The leaf improves digestion and assimilation, particularly in those who do not digest food well or have chronic ill health. The leaves also increase diuresis.^[105] Coriander leaf also has shown antioxidant and antiplatelet activities.^[106,107] Nutritional content of leaves per 100 g is mentioned in Table 6.^[108]

Asafoetida

This spice is used as a digestive aid, in treating stomach ache, has antifatulent and antimicrobial activities, and as a remedy for asthma and bronchitis.^[109-112] Asafoetida contains about 40%–64% resin, 25% endogeneous gum, 10%–17% volatile oil, and 1.5%–10% ash. The resin portion contains asaresinotannols “A” and “B,” ferulic acid, and umbelliferone.^[113]

CONCLUSION AND FUTURE PROSPECTS

Rasam is a classic example of traditional functional food with all its ingredients medicinally claimed for various ailments. Moreover, the processing in the formulation of *rasam* involves heating the spices in water and oil. This processing provides tremendous opportunity for a completely altered/different chemical composition of the finally formulated *rasam*. Loss of active principles or synergetic effect or breakdown of inactive metabolite to an active one or formation of new chemical entities (NCEs) is a real possibility. Moreover, a better understanding of chemistry of constituents during traditional formulation processes will provide the following;

1. New leads based on structure–activity relationship studies of chemical constituents
2. Interesting leads can be obtained on the novel chemical structure of NCEs from the formulation
3. Possibility of deriving new knowledge on the mechanism of action, which in turn may help in better understanding of the etiopathogenesis and the course of diseases
4. Interactions between chemical constituents of different ingredients will provide unique combination for studying interaction between organic and inorganic constituents.

Traditional functional foods can help prevent chronic disease or optimize health, therefore reducing health-care costs and improving the quality of life. A study on *rasam*, which is being consumed from time immemorial, is only an approach of “drug rediscovery.” In view of all

the above facts, *rasam* should be extensively explored with the modern scientific approaches to identify its physiological actions beyond culinary and nutritional effects.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Tapsell LC, Hemphill I, Cobiac L, Patch CS, Sullivan DR, Fenech M, *et al.* Health benefits of herbs and spices: The past, the present, the future. *Med J Aust* 2006;185 4 Suppl:S4-24.
2. Lampe JW. Spicing up a vegetarian diet: Chemopreventive effects of phytochemicals. *Am J Clin Nutr* 2003;78 3 Suppl:579S-83S.
3. Opara EI, Chohan M. Culinary herbs and spices: Their bioactive properties, the contribution of polyphenols and the challenges in deducing their true health benefits. *Int J Mol Sci* 2014;15:19183-202.
4. Sainani GS, Desai DB, Gorhe NH, Natu SM, Pise DV, Sainani PG. “Dietary garlic, onion and some coagulation parameters in Jain community.” *J Assoc Physicians India* 1979;27:707-12.
5. Wagner H. Multitarget therapy – The future of treatment for more than just functional dyspepsia. *Phytomedicine* 2006;13 Suppl 5:122-9.
6. Patwardhan B, Khambholja K. Drug discovery and Ayurveda: Win-win relationship between contemporary and ancient sciences. In: Kapetanovic I, editor. *Drug Discovery and Development – Present and Future*. Croatia: In Tech; 2011. p. 9.
7. Wikipedia.org. San Francisco: Wikimedia Foundation, Inc. Available from: https://www.en.wikipedia.org/wiki/Functional_food. [Last updated on 2016 Nov 27; Cited on 2017 Jan 09].
8. Grajek W, Olejnik A, Sip A. Probiotics, prebiotics and antioxidants as functional foods. *Acta Biochim Pol* 2005;52:665-71.
9. Choudhary R, Tandon RV. Consumption of functional food and our health concerns. *Pak J Physiol* 2009;5:76-83.
10. Srinivasan K. Traditional Indian functional foods. In: Shi J, Ho CT, Shahidi F, editors. *Functional Foods of the East, Nutraceutical Science and Technology*. Series 10. Florida: Taylor & Francis Group; 2010. p. 51-76.
11. Vijayalakshmi B, Swamy BV, Shantha TR. Ayurvedic rationale of the southern Indian vegetable soup saaru or rasam. *Anc Sci Life* 1998;17:207-13.
12. Weiss RS. *Recipes for Immortality: Healing, Religion, and Community in South India*. Wellington: Oxford University Press; 2009.
13. Zarraga IG, Schwarz ER. Impact of dietary patterns and interventions on cardiovascular health. *Circulation* 2006;114:961-73.
14. Retelny VS, Neuendorf A, Roth JL. Nutrition protocols for the prevention of cardiovascular disease. *Nutr Clin Pract* 2008;23:468-76.
15. Upadhyaya Y. *Astangahradaya*. Varanasi: The Chaukhamba Sanskrit Sansthan; 1975.
16. Todiwala C. *Mr Todiwala's spice box: 120 recipes with just 10 spices*. London: Octopus Publishing Group; 2016.
17. Srinivasan K. Spices as influences of body metabolism; an overview of three decades of research. *Food Res Int* 2005;38:77-86.
18. Berzok LM. *Storied Dishes: What Our Family Recipes Tell Us about who We are and Where We've Been*. California: Greenwood Press; 2011.
19. Nande P, Harode S, Valle M, Vali SA. Nutrient contents in selected Maharashtrian and South Indian single full meals. *J Dairying Foods Home Sci* 2008;27:53-64.
20. Kapoor S. *Sanjeev Kapoor's Khana Khazana: Celebration of Indian Cookery*. Mumbai: Popular Prakashan Pvt. Ltd.; 2004.
21. Singh A, Walia I, Dhaliwal L. *Demedicalizing Women's Health*. Vol. 2. New Delhi: Gyan Publishing House; 2010.
22. Wikipedia.org. San Francisco: Wikimedia Foundation, Inc. Available from: <https://www.en.wikipedia.org/wiki/Rasam>. [Last updated on 2017 Mar 04; Cited on 2017 Mar 13].
23. Padmanabhan C. *Simply South Traditional Vegetarian Cook*. Chennai: Westland Ltd.; 2008.
24. Parthasarathy VA, Chempakam B, Zachariah TJ, editors. *Chemistry of Spices*. 1st ed. Oxfordshire: CAB International; 2008.
25. Sanmugam D, Kasinathan S. *Indian Heritage Cooking*. Singapore: Marshall Cavendish

- International Asia Pvt. Ltd.; 2011.
26. Shodhganga.inflibnet.ac.in. Kodaikanal: Department of Home Science, Mother Teresa Womens University. Health and Nutritional Status of Tribal Women at Krishnagiri District. Available from: http://www.shodhganga.inflibnet.ac.in/bitstream/10603/32725/16/16_summary%20and%20conclusion.pdf. [Last updated on 2015 Jan 04; Cited on 2017 Mar 20].
 27. Devi KK, Priyadarshini VP. Exploration of nutrient content of traditional recipes of Tamil Nadu with therapeutic properties. *Int J Res Appl Nat Soc Sci* 2014;2:1-12.
 28. Mani UV, Mani IU, Iyer UM, Prakash B, Manivannan T, Campbell S, *et al.* Glycemic and lipemic response to various regional meals and South Indian snacks. *Int J Diabetes Dev Ctries* 1997;17:75-81.
 29. Banerjee S. Cooking for diabetics, diet plays a very important role in any disease, more so in diabetes. New Delhi: Pustak Mahal Publishers; 2004.
 30. Bolla K, Santhi KV, Afnan KS, Krishnaveni P, Kusuma M. Effect of diet counseling on type 2 diabetes mellitus. *Int J Sci Technol Res* 2015;4:112-8.
 31. Rani VE, Paulraj S. Impact of dietary intervention with a functional food supplement to combat anemia – The blood iron metabolic disorder among the coffee plantation labourers. *Funct Food Health Dis* 2013;3:21-36.
 32. Mamatha C, Prakash J. Formulation of iron fortified masala powders and assessment of nutritional and sensory qualities. *Indian J Nutr Dietetics* 2016;53:330-42.
 33. Salau RB, Hasan MR. Evaluation and analysis of dietary essential mineral micronutrients in selected Malaysian foods using FAAS and ICP-MS. *Mod Appl Sci* 2014;8:103-11.
 34. Rajan S, Baburaj DS, Sethuraman M, Parimala S. Stem and stem bark used medicinally by the tribals Irulas and Paniyas of Nilgiri district, Tamil Nadu. *J Nat Rem* 2001;1:49-54.
 35. Rao PD, Babu MS, Rao VL. Persistent traditional practices among the tribals of north coastal Andhra Pradesh. *Stud Tribes Tribals* 2006;4:53-6.
 36. Nithya TG, Dahineeswari V, Chowdhury SR, Sivakumar S. Antibacterial activity of thaleesaadhi chooranam against human pathogens. *Int J Drug Discov Herb Res* 2011;1:224-30.
 37. Swapna B. An ethnobotanical survey of plants used by Yanadi tribe of Kavali, Nellore district, Andhra Pradesh, India. *J Sci Innov Res* 2015;4:22-6.
 38. Dudhatra GB, Mody SK, Awale MM, Patel HB, Modi CM, Kumar A, *et al.* A comprehensive review on pharmacotherapeutics of herbal bioenhancers. *ScientificWorldJournal* 2012;2012:637953.
 39. Nayak AK, Nayak SG. Chickenpox-customs, beliefs and traditional practices in Udipi district: A case study. *Nitte Univ J Health Sci* 2013;3:102-4.
 40. Suri MP, Patel CK, Dhingra VJ, Raibagkar SC, Mehta DR. Nutrition in burns: A practical solution to a difficult problem. *Indian J Plast Surg* 2006;39:62-4.
 41. Glew RS, Vanderjagt DJ, Chuang LT, Huang YS, Millson M, Glew RH. Nutrient content of four edible wild plants from West Africa. *Plant Foods Hum Nutr* 2005;60:187-93.
 42. El-Siddiq K, Gunasena HP, Prasad BA, Pushpakumara DK, Raman KV, Vijayanand P, *et al.* Tamarind: *Tamarindus indica* L. Southampton, UK: International Centre for Underutilised Crops; 2006.
 43. Doughari JH. Antimicrobial activity of *Tamarindus indica*. *Trop J Pharm Res* 2006;5:597-603.
 44. Havinga RM, Hartl A, Putscher J, Prehler S, Buchmann C, Vogl CR. *Tamarindus indica* L. (*Fabaceae*): Patterns of use in traditional African medicine. *J Ethnopharmacol* 2010;127:573-88.
 45. Panthong A, Khonsung P, Kunanusorn P, Wongcome T, Pongsamart S. The laxative effect of fresh pulp aqueous extracts of Thai tamarind cultivars. *Planta Med* 2008;74:PH40.
 46. De Caluwe E, Halamova K, Damme PV. *Tamarindus indica* L. – A review of traditional uses, phytochemistry and pharmacology. *Afr Focus* 2010;23:53-83.
 47. Imam S, Azhar I, Hasan MM, Ali MS, Ahmed SW. Two triterpenes lupanone and lupeol isolated and identified from *Tamarindus indica* linn. *Pak J Pharm Sci* 2007;20:125-7.
 48. Wong KL, Tan CP, Chow CH, Chee SG. Volatile constituents of the fruit of *Tamarindus indica* L. *Essent Oil Res* 1998;10:219-21.
 49. Shankaracharya NB. Tamarind – Chemistry, technology and uses – A critical appraisal. *J Food Sci Technol* 1998;35:193-208.
 50. Isha D, Milind P. Imli: A craze lovely. *Int Res J Pharm* 2012;3:110-5.
 51. Roy MG, Rahman S, Rehana F, Munmun M, Sharmin N, Hasan Z, *et al.* Evaluation of anti-hyperglycemic potential of methanolic extract of *Tamarindus indica* L. (*Fabaceae*) fruits and seeds in glucose-induced hyperglycemic rats. *Adv Nat Appl Sci* 2010;4:159-62.
 52. Pimple BP, Kadam PV, Badgujar NS, Bafna AR, Patil MJ. Protective effect of *Tamarindus indica* Linn against paracetamol induced hepatotoxicity in rats. *Indian J Pharm Sci* 2007;69:827-31.
 53. Daniyan SY, Muhammad HB. Evaluation of the antimicrobial activities and phytochemical properties of extracts of *Tamarindus indica* against some diseases causing bacteria. *Afr J Biotechnol* 2008;7:2451-3.
 54. Ndb.nal.usda.gov. Beltsville, Maryland: USDA Food Composition Databases, Agricultural Research Service, United States Department of Agriculture. Available from: <https://www.ndb.nal.usda.gov/ndb/foods/show/2391?format=Full&reportfmt=pdf&pdfQvs=%7BQv%3D1%7D&ds=>. [Cited on 2017 Mar 06].
 55. Joshi AA, Kshirsagar RB, Sawate AR. Studies on standardization of enzyme concentration and process for extraction of tamarind pulp, variety Ajanta. *J Food Process Technol* 2012;3:141-3.
 56. Prasad S, Aggarwal BB, Benzie IF, Wachtel-Galor S. Turmeric, the golden spice: From traditional medicine to modern medicine. In: Benzie IF, Wachtel-Galor S, editors. *Herbal Medicine: Biomolecular and Clinical Aspects*. Boca Raton (FL): CRC Press; 2011. p. 263-88.
 57. Itokawa H, Shi Q, Akiyama T, Morris-Natschke SL, Lee KH. Recent advances in the investigation of curcuminoids. *Chin Med* 2008;3:11.
 58. Ttayem RF, Heath DD, Al-Delaimy WK, Rock CL. Curcumin content of turmeric and curry powders. *Nutr Cancer* 2006;55:126-31.
 59. Nagpal M, Sood S. Role of curcumin in systemic and oral health: An overview. *J Nat Sci Biol Med* 2013;4:3-7.
 60. Ndb.nal.usda.gov. Beltsville, Maryland: USDA Food Composition Databases, Agricultural Research Service, United States Department of Agriculture. Available from: <https://www.ndb.nal.usda.gov/ndb/foods/show/292?format=Abridged&reportfmt=pdf&pdfQvs=%7BQv%3D1%7D&ds=>. [Cited on 2017 Mar 06].
 61. Druesne-Pecollo N, Latino-Martel P, Norat T, Barrandon E, Bertrais S, Galan P, *et al.* Beta-carotene supplementation and cancer risk: A systematic review and metaanalysis of randomized controlled trials. *Int J Cancer* 2010;127:172-84.
 62. Russell RM. The enigma of beta-carotene in carcinogenesis: What can be learned from animal studies. *J Nutr* 2004;134:262S-8S.
 63. Stargrove MB, Treasure J, McKee DL. *Herb, Nutrient, and Drug Interactions: Clinical Implications and Therapeutic Strategies*. 1st ed. Missouri: Mosby Elsevier; 2008.
 64. Fda.gov. US Food and Drug Administration. Qualified Health Claims: Letter Regarding Tomatoes and Prostate Cancer (Lycopene health claim coalition) (Docket No. 2004q-0201). Available from: <https://www.fda.gov/Food/IngredientsPackagingLabeling/LabelingNutrition/ucm072767.htm>. [Last updated on 2005 Nov 08; Cited on 2017 Mar 13].
 65. Burton-Freeman B, Sesso HD. Whole food versus supplement: comparing the clinical evidence of tomato intake and lycopene supplementation on cardiovascular risk factors. *Adv Nutr* 2014;5:457-85.
 66. Hackshaw-McGeagh LE, Perry RE, Leach VA, Qandil S, Jeffreys M, Martin RM, *et al.* A systematic review of dietary, nutritional, and physical activity interventions for the prevention of prostate cancer progression and mortality. *Cancer Causes Control* 2015;26:1521-50.
 67. Ndb.nal.usda.gov. Beltsville, Maryland: USDA Food Composition Databases, Agricultural Research Service, United States Department of Agriculture. Available from: <https://www.ndb.nal.usda.gov/ndb/foods/show/3223?format=Full&reportfmt=pdf&pdfQvs=%7BQv%3D1%7D&ds=>. [Cited on 2017 Mar 06].
 68. Fattori V, Hohmann MS, Rossaneis AC, Pinho-Ribeiro FA, Verri WA. Capsaicin: Current understanding of its mechanisms and therapy of pain and other pre-clinical and clinical uses. *Molecules* 2016;21. pii: E844.
 69. Ndb.nal.usda.gov. Beltsville, Maryland: USDA Food Composition Databases, Agricultural Research Service, United States Department of Agriculture. Available from: <https://www.ndb.nal.usda.gov/ndb/foods/show/3436?format=Abridged&reportfmt=pdf&pdfQvs=%7BQv%3D1%7D&ds=>. [Cited on 2017 Mar 06].
 70. Farrell KT. *Spices, Condiments and Seasonings*. 2nd ed. Maryland: The Aspen Publishers Inc.; 1999.
 71. Lee HS. Cuminaldehyde: Aldose reductase and α -glucosidase inhibitor derived from *Cuminum cyminum* L. seeds. *J Agric Food Chem* 2005;53:2446-50.
 72. Willatgamuwa SA, Patel K, Saraswathi G, Srinivasan K. Antidiabetic influence of dietary cumin seeds (*Cuminum cyminum*) in streptozotocin induced diabetic rats. *Nutr Res* 1998;18:131-42.
 73. Singh RP, Gangadharappa HV, Mruthunjaya K. *Cuminum cyminum* – A popular spice: An updated review. *Pharmacogn J* 2017;9:292-301.
 74. Ndb.nal.usda.gov. Beltsville, Maryland: USDA Food Composition Databases, Agricultural Research Service, United States Department of Agriculture. Available from: <https://www.ndb.nal.usda.gov/ndb/foods/show/264?format=Abridged&reportfmt=pdf&pdfQvs=%7BQv%3D1%7D&ds=>. [Cited on 2017 Mar 06].
 75. Borlinghaus J, Albrecht F, Gruhke MC, Nwachukwu ID, Slusarenko AJ. Allicin: Chemistry and

- biological properties. *Molecules* 2014;19:12591-618.
76. Rahman K. Effects of garlic on platelet biochemistry and physiology. *Mol Nutr Food Res* 2007;51:1335-44.
 77. Nahas R, Balla A. Complementary and alternative medicine for prevention and treatment of the common cold. *Can Fam Physician* 2011;57:31-6.
 78. Iyer A, Panchal S, Poudyal H, Brown L. Potential health benefits of Indian spices in the symptoms of the metabolic syndrome: A review. *Indian J Biochem Biophys* 2009;46:467-81.
 79. Banerjee SK, Dinda AK, Manchanda SC, Maulik SK. Chronic garlic administration protects rat heart against oxidative stress induced by ischemic reperfusion injury. *BMC Pharmacol* 2002;2:16.
 80. Weber ND, Andersen DO, North JA, Murray BK, Lawson LD, Hughes BG. *In vitro* virucidal effects of *Allium sativum* (garlic) extract and compounds. *Planta Med* 1992;58:417-23.
 81. Hassan HT. Ajoene (natural garlic compound): A new anti-leukaemia agent for AML therapy. *Leuk Res* 2004;28:667-71.
 82. Tilli CM, Stavast-Kooy AJ, Vuerstaek JD, Thissen MR, Krekels GA, Ramaekers FC, et al. The garlic-derived organosulfur component ajoene decreases basal cell carcinoma tumor size by inducing apoptosis. *Arch Dermatol Res* 2003;295:117-23.
 83. Terrasson J, Xu B, Li M, Allart S, Davignon JL, Zhang LH, et al. Activities of Z-ajoene against tumour and viral spreading *in vitro*. *Fundam Clin Pharmacol* 2007;21:281-9.
 84. Ndb.nal.usda.gov. Beltsville, Maryland: USDA Food Composition Databases, Agricultural Research Service, United States Department of Agriculture. Available from: <https://www.ndb.nal.usda.gov/ndb/foods/show/2968?format=Full&reportfmt=pdf&pdfQvs=%7BQv%3D1%7D&ds=>. [Cited on 2017 Mar 06].
 85. Vallette L, Rabadeaux C, Sirdaarta J, Davis C, Cock IE. An upscaled extraction protocol for *Tasmannia lanceolata* (Poir.) A.C. Sm.: Anti-bacterial, anti-giardial and anticancer activity. *Pharmacogn Commun* 2016;6:238-54.
 86. Butt MS, Pasha I, Sultan MT, Randhawa MA, Saeed F, Ahmed W. Black pepper and health claims: A comprehensive treatise. *Crit Rev Food Sci Nutr* 2013;53:875-86.
 87. Vijayakumar RS, Surya D, Nalini N. Antioxidant efficacy of black pepper (*Piper nigrum* L.) and piperine in rats with high fat diet induced oxidative stress. *Redox Rep* 2004;9:105-10.
 88. Westerterp-Plantenga M, Diepvens K, Joosen AM, Bérubé-Parent S, Tremblay A. Metabolic effects of spices, teas, and caffeine. *Physiol Behav* 2006;89:85-91.
 89. Srinivasan K. Black pepper and its pungent principle-piperine: A review of diverse physiological effects. *Crit Rev Food Sci Nutr* 2007;47:735-48.
 90. Khajuria A, Thusu N, Zutshi U. Piperine modulates permeability characteristics of intestine by inducing alterations in membrane dynamics: Influence on brush border membrane fluidity, ultrastructure and enzyme kinetics. *Phytomedicine* 2002;9:224-31.
 91. Dawid C, Henze A, Frank O, Glabasnia A, Rupp M, Büning K, et al. Structural and sensory characterization of key pungent and tingling compounds from black pepper (*Piper nigrum* L.). *J Agric Food Chem* 2012;60:2884-95.
 92. Ndb.nal.usda.gov. Beltsville, Maryland: USDA Food Composition Databases, Agricultural Research Service, United States Department of Agriculture. Available from: <https://www.ndb.nal.usda.gov/ndb/foods/show/280?format=Abridged&reportfmt=pdf&pdfQvs=%7BQv%3D1%7D&ds=>. [Cited on 2017 Mar 06].
 93. Tainter RD, Grenis AT. Spices and Seasonings: A Food Technology Handbook. 2nd ed. New York: John Wiley & Sons; 2001.
 94. Lahorkar P, Ramitha K, Bansal V, Anantha Narayana DB. A comparative evaluation of medicated oils prepared using ayurvedic and modified processes. *Indian J Pharm Sci* 2009;71:656-62.
 95. Ndb.nal.usda.gov. Beltsville, Maryland: USDA Food Composition Databases, Agricultural Research Service, United States Department of Agriculture. Available from: <https://www.ndb.nal.usda.gov/ndb/foods/show/662?format=Abridged&reportfmt=pdf&pdfQvs=%7BQv%3D1%7D&ds=>. [Cited on 2017 Mar 06].
 96. Khan BA, Abraham A, Leelamma S. Hypoglycemic action of *Murraya koenigii* (curry leaf) and *Brassica juncea* (mustard): Mechanism of action. *Indian J Biochem Biophys* 1995;32:106-8.
 97. Srinivasan K. Plant foods in the management of diabetes mellitus: Spices as beneficial antidiabetic food adjuncts. *Int J Food Sci Nutr* 2005;56:399-414.
 98. Ndb.nal.usda.gov. Beltsville, Maryland: USDA Food Composition Databases, Agricultural Research Service, United States Department of Agriculture. Available from: <https://www.ndb.nal.usda.gov/ndb/foods/show/274?format=Abridged&reportfmt=pdf&pdfQvs=%7BQv%3D1%7D&ds=>. [Cited on 2017 Mar 06].
 99. Prajapati ND, Purohit SS, Sharma AK, Kumar TA. Handbook of Medicinal Plants. Jodhpur: Agrobios (India); 2003.
 100. Ramaswamy L, Kanmani MG. Phytonutrient profile, health benefits and culinary applications of selected edible foliage. *Int J Ayurvedic Herb Med* 2012;2:469-76.
 101. Jain V, Momin M, Laddha K. *Murraya koenigii*: An updated review. *Int J Ayurvedic Herb Med* 2012;2:607-27.
 102. Sujatha R, Srinivas L. Modulation of lipid peroxidation by dietary components. *Toxicol In Vitro* 1995;9:231-6.
 103. Shah AS, Juvekar AR. Immunostimulatory activity of aqueous extract of *Murraya koenigii* (Linn.) Spreng. leaves. *Indian J Nat Prod Resour* 2010;1:450-5.
 104. Prakash V, Natarajan CP. Studies on curry leaf. *J Food Sci Technol* 1974;11:284-6.
 105. National Institute of Science Communication and Information Resources; Council of Scientific and Industrial Research. The Wealth of India, a Dictionary of Indian Raw Materials and Industrial Products, First Supplement Series (Raw Materials). Vol. 2 (Cl-Cy). New Delhi (India): NISCOM, CSIR; 2001. p. 203-6.
 106. Mahendra P, Bisht S. *Coriandrum sativum*: A daily use spice with great medicinal effect. *Pharmacogn J* 2011;3:84-8.
 107. Suneetha WJ, Krishnakantha TP. Antiplatelet activity of coriander and curry leaf spices. *Pharm Biol* 2003;43:230-3.
 108. Ndb.nal.usda.gov. Beltsville, Maryland: USDA Food Composition Databases, Agricultural Research Service, United States Department of Agriculture. Available from: <https://www.ndb.nal.usda.gov/ndb/foods/show/2931?format=Full&reportfmt=pdf&pdfQvs=%7BQv%3D1%7D&ds=>. [Cited on 2017 Mar 06].
 109. Morningstar A, Desai U. The Ayurvedic Cookbook: A Personalized Guide to Good Nutrition and Health. New Delhi: Motilal Banarsidass Publications; 2003.
 110. Srinivasan K. Role of spices beyond food flavoring: Nutraceuticals with multiple health effects. *Food Rev Int* 2005;21:167-88.
 111. Aggarwal H, Kotwal N. Foods used as ethno-medicine in Jammu. *Ethno Med* 2009;3:65-8.
 112. Mahendra P, Bisht S. Ferula asafoetida: Traditional uses and pharmacological activity. *Pharmacogn Rev* 2012;6:141-6.
 113. Singhal RS, Kulkarni PR, Rege DV. Handbook of Indices of Food Quality and Authenticity. Cambridge: Woodhead Publishing; 1997.