Pharmaco-Botanical Studies on *Capsicum frutescens* L.

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Abstract

Capsicum frutescens L. is used as drug and spice in Indian traditions. The drug (dried fruit), which is stimulant, antispasmodic, carminative, diaphoretic, counterirritant, antiseptic and rubeacient. The plants have also been used as folk remedies for dropsy, colic, diarrhea, asthma, arthritis, muscle cramps, and toothache. Consumption of red pepper may aggravate symptoms of duodenal ulcers. The present studies deal with detailed pharmacognostic studies and review related medicinal aspects of drug.

Key Words: *Capsicum frutescens* L., Drug standardization, Quality specifications.

Introduction

Capsicum frutescens L. (Family – Solanaceae) is commonly known as 'Chilly' or 'Paprika'; it is widely used as a pungent spice. The fruit of the capsicum plant is a common ingredient in many recipes. *C. frutescens* L. is an annual herb up to 1 m high, while other species are usually perennial woody shrub, the plant is indigenous to tropical America, Africa and widely cultivated. The plant derives its names from the Latin *capsa*, meaning box, referring to the partially hollow, box-like fruit. Capsicum was first mentioned in 1494 by Chauca, a physician who accompanied Columbus on his second voyage to West Indies plants were introduced into India by the Portuguese at an early date and later into Africa (Robbers *et al.*, 1996).

The medicinal values of Capsicum as a counterirritant depend on its pungency. This spice is also used as a homeopathic treatment for a variety of conditions. Capsicum is credited with a number of medicinal properties in different systems of medicines. As a medicinal plant, the Capsicum has been used as a carminative, digestive irritant, stomachic, stimulant, rubefacient, and tonic, it used in native practice in typhus, intermittent fevers, and dropsy also in gaunt, dyspepsia, and cholera. Externally it used as rubefacient, neuralgia and internally for colic, flatulent dyspepsia, chronic laryngitis, insufficiency of peripheral circulation (Ebadi, 2002).

Methodology

Drug samples were collected from different places as well from commercial sources with a view to find out any significant difference present within the

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same species. For studying powder, Jackson and Snowdon (1992) was followed. To determine physico-chemical constants, Indian Pharmacopoeia (Anonymous, 1955 & 1966) was consulted and for fluorescence study schedules mentioned by Trease and Evans (1972) were followed. Colours were named by consulting Rayner (1970). Standard prescribed procedures for histochemical studies (Johanson, 1940; Youngken, 1951; Cromwell, 1955; Trease and Evans, 1978), organic group detection (Robinson, 1963); U.V. Spectrophotometry (Willard *et al*., 1965) and Chromatography (Shellard, 1968; Stahl, 1969; Smith and Feinberg, 1972) were adopted. The informatics is complied by reviewing the available literature.

Informatics

Systematics

Family: Solanaceae

Genus: *Capsicum*

Capsicum frutescens L. is perennial erect herb or small sub herb 1-2 m high; branches angular. Leaves alternate, petiolate, simple, broadly ovate, and pointed with entire margins. Flowers born usually single in leaf and branch axils, white to violet, five-parted. Fruit a dry to fleshy red elongated, ovoid, obtuse or oblong berry with numerous flattened seeds (Fig. 1A).

Distribution: Capsicum native of the West Indies and tropical America is most probably of Brazil. Capsicum is cultivated in India since ancient times, commonly cultivated throughout the plains of India, and on the lower hills such as Kashmir and Chenab valley.

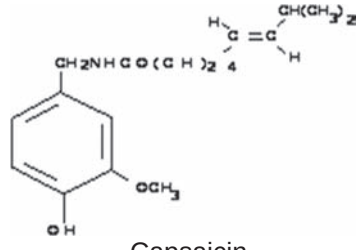
Drug Specification: The drug consist of dried ripe fruits.

Nomenclature:

The plant is known by different vernacular names e.g. Gachmarich, Lallankamurich and Lalmarich (Bengali), Mirchi (Gujarati), Gachmirich, Lalmirch and Lankamirchi (Hindi), Chabai, Chabelombok, Kappalmelaka, and Ladumira (Malayalam), Mirchi (Marathi), Mullagay (Tamil), Golakonda (Telugu) and Lalmarach (Urdu) etc.

Chemical Constituents:

Capsicum contains Capsaicinoids pungent principals, which are composed mainly major components capsaicin, dihydrocapsaicin,



Capsaicin

nordihydrocapsaicin, homodihydrocapsaicin and homocapsaicin. Capsicum also contain about 1.5 % of volatile oil, a fixed oil, carotenoids pigments (capsanthin, capsorubin, carotene, lutein).Other constituents proteins, fats, vitamins A and C,ascorbic acid, caffeic acid, caproic acid, cinnamic acid, para-coumaric acid, ferulic acid, mevalonic acid, pyrazine derivative, capsidiol, kaempferol derivative, quercetin derivative, lipids,pentosans, pectins.Acitic, butric and isobyteric acids.(Leug *et al.*, 1996; Roboers *et al.*, 1996; Barness *et al.*, 2002; Heurich *et al.*, 2004)

Pharmacology

Capsicum is a powerful local stimulant, its oleoresin or active principles capsaicin, it used as a neurochemical tool for studying sensory neurotransmission. Capsicum oleoresin and capsaicin are ingredients for relief of pain in muscle, tendon and joints. The protective effect of capsaicin acts on vanilloid receptors; it is used as a local analgesic in the treatment of post-herpetic neuralgia, shingles, diabetic, rhinopathy and osteoarthritis, neuropathy and other forms of intractable pain (Barness *et al.,* 2002). Digestive properties of capsaicin may be attributed to an enhancement of digestive enzyme activities or to indirect effects on vascular endothelia, smooth muscles and mast cell, increase of vascular permeability and mucosal blood flow. Body temperature, flow of saliva, and gastric juices may be stimulated by capsicum peppers Capsicum strongly irritant to eyes and tender skin, producing an intense burning sensation (Duke *et al.,* 2002).

Therapeutic and non-therapeutic uses

Capsicum is stated to possess stimulant, antispasmodic, carminative, diaphoretic, counterirritant, antiseptic and rubeacient.Traditionally, it used as remedy for diseases of skin, tuberculosis, mild conjunctivitis, it also has been used for colic, flatulent dyspepsia without inflammation, chronic laryngitis, insufficiency of peripheral circulation and externally for neuralgia including rheumatic pains and unbroken chilblains. Capsicum is useful for treating sore throats (Barness *et al.,* 2002).

Capsicum species are used fresh or dried, whole or alone and in combination with other flavoring agents. The extracts of Capsicum species have been reported to have antioxidant properties. Paprika is derived from *C. frutescens* L. and is used primarily in the flavoring of garnishes, pickles, meats, barbecue sauces, ketchup, cheese, snack food, dips, chili con came, salads, sausages and widely used as coloring agents. Chilies and chili pepper used

as a flavoring in many foods, such as curry powder and Tabasco sauce. Chili powder is a blend of spices that includes ground chilies.

The plants have also been used as folk remedies for dropsy, colic, diarrhea, asthma, arthritis, muscle cramps, and toothache. Consumption of red pepper may aggravate symptoms of duodenal ulcers. It is administered in the form of powder, tincture, liniment, plaster, ointment and used as a balm or cream, clinical trials have shown it effective in reducing pain and other neuropathy sensations. In some of these preparations, oleoresin Capsici B.P.C. syn. Capsaicin, the alcohol soluble fraction of the ether extract of capsicum is the active ingredient.

Adulterations and Substitutes

Adulterants in chilly powder are brick powder, soap stone and some artificial colors. Powdered fruits of 'Choti ber' (*Ziziphus nummularia*), red beet pulp, almond shell dust, extra amounts of bleached pericarp, seed, calyx and peduncle of chilly, starch of cheap origin, tomato waste and sweet bell peppers, paprika, pimento (Spanish paprika), and other red pepper products.

Regulatory Status: An official drug in Indian Pharmacopoeia, 1955 & 1966 and also covered under Food Safety and Standards Regulation 2011 (Anonymous, 1955, 1966 & 2011).

A. Flowering Plant

B. Seeds

C. Seeds (Magnified)

D. Seed Powdered

Fig. 1: *Capsicum frutescens* L.

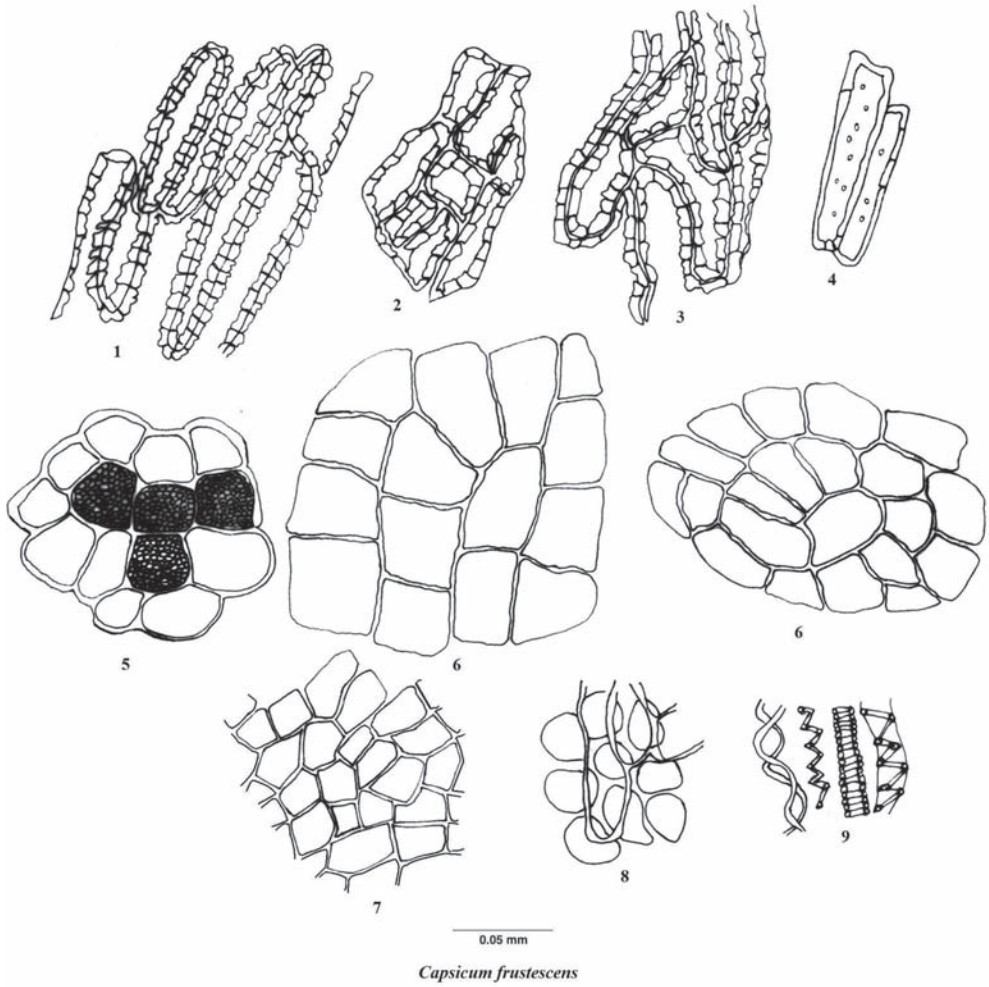


Fig. 2: 1. 2. 3. Elongated sclereids of endocarp in surface view; 4. Oblique longitudinal sclereids of endocarp; 5. Cells of endosperm of seed; 6. Epicarp cells; 7. Parenchymatous tissue; 8. Parenchyma of testa with underlying endosperm surface view; 9. Vessels.

Observations

I. Organoleptic Characteristics

Entire Drug—Fruit are 2.5 to 3.0 cm inches long and 1 cm wide; pod like berry, laterally compressed, conical, base blunt, apex sharp, pointed; calyx and peduncle usually attached to the larger fruits, and some times to the smaller; colour brownish-red to a rich deep-red, (Fig. 1 B,C)).

Powdered Drug – The powder is red in colour; odour characteristic, sternutatory, but not pleasant; taste is mild to slightly pungent (Fig. 1 D).

II. Micro-Morphological Characteristics

Powdered Drug- Pale yellow, single layer of polygonal to slightly elongated cells of epicarp in surface view. Epidermal cells are vary in shape, mostly rectangular-oblong or rectangular-square. Fragments of mesocarp are frequently attached to the epicarp or endocarp, usually containg red to orange oily globules. The sclereids of the endocarp occur in groups, in a single layer and may be found attached with parenchyma. The sclereids are polygonal to elongated in surface view, have sinuous walls and numerous distinct pits. The fragments of endosperm frequently found attached of the parenchyma of testa (Fig. 2).

III. Histochemistry

Micro – Chemical Tests and Behaviour of specific reagents towards Plant/Drug Tissues – Observations and results pertaining to micro-chemical tests and behavior of specific reagent towards plant tissues are presented in Table 1.

Table 1: Micro-chemical Tests and behaviour of specific reagents towards plant tissues and cells contents.

Sl. No.	Reagent	Test for	Inference	Histological zone/cell contents responded
1.	Dragendorff's reagent	Alkaloid	+	Mesocarp cells
2.	Marme's reagent	Alkaloid	+	Same as above
3.	Wagner's reagent	Alkaloid	+	Same as above
4.	Potassium hydroxide solution (5% w/v)	Anthocynin	+	Epicarp & Mesocarp cells
5.	Sulphuric acid (66% v/v)	Anthocynin	+	Same as above
6.	Acetic acid	Calcium oxalate	_	Not Responded
7.	Potassium hydroxide solution (5% v/v) + Hydrochloric acid	Calcium oxalate	_	Not Responded
8.	Sulphuric acid	Calcium oxalate	_	Not Responded
9.	Kedde reagent	Cardiac glycoside	_	Not Responded
10.	Iodine Solution followed by Sulphuric acid	Cellulose	+	Epicarp, mesocarp and other cellular region

Sl. No.	Reagent	Test for	Inference	Histological zone/cell contents responded
11.	Sudan III	Fixed oil and fats	_	Not Responded
12.	Chlor-zinc-Iodine Solution	Latex	_	Not Responded
13.	Aniline sulphate Solution followed by Sulphuric acid	Lignin	+	Vascular strands
14.	Phloroglucinol HCl	Lignin	+	Same as above
15.	Lugol's solution	Protein	+	Endosperm cells
16.	Millon's reagent	Protein	+	Same as above
17.	Picric acid	Protein	+	Same as above
18.	Heating with KOH (5% w/v) + H_2SO_4	Suberin	_	Not Responded
19.	Sudan III	Suberin	_	Not Responded
20.	Weak Iodine solution	Starch	+	All starch grains
21.	Potassium hydroxide solution (5% w/v)	Starch	+	Same as above
22.	Sulphuric acid	Starch	+	Same as above

Indications: '-' Absence and '+' presence of constituent.

Organic Groups of Chemical Constituents – The extracts of the drug were tested for presence of different organic groups and results are presented in Table 2.

Table 2: Major Group of Organic Chemical Constituents of Drug.

Sl. No.	Organic Groups of Chemical Constituents	Reagents/Tests	Inference
1.	Alkaloid	Dragendorff's and Mayer's reagents	+
2.	Anthraquinone	Borntrager reaction	+
3.	Coumarin	Alcoholic potassium hydroxide	+
4.	Flavonoid	Shinoda reaction	+
5.	Glycoside	Mollisch's test	+
6.	Protein	Xanthoprotein test	+
7.	Resin	Ferric chloride regent	_
8.	Saponin	Libermann-Burchard reaction	+
9.	Steroid	Salkowski reaction	+
10.	Tannin	Gelation test	_

IV. Identity, Purity & Strength

Physico-Chemical Constants – The analytical values in respect of physico-chemical constant of drug were established and results are reported in Table 3.

Table 3: Analytical Values of Physico-chemical Constants

Sl. No.	Physico-Chemical Contents	Analytical values
		Capsicum frutescens L.
1.	Moisture content, % w/w, Not more than	6.0
2.	pH	7.2
3.	Total Ash, % w/w	14.5
4.	Acid insoluble ash, % w/w, Not less than	2.5
5.	Alcohol soluble extractive % w/w, Not less than	15.6
6.	Water soluble extractive % w/w, Not less than	33.0
7.	Essential Oil, % v/w, Not less than	_

V. Fluorescence & Spectroscopy

Fluorescence Characteristic of Powdered drug under Ultra-Violet Light – Powdered drug was screened for fluorescence characteristic with or without chemical treatment. The observations pertaining to their colour in daylight and under ultra-violet light were noticed and are presented in Table 4.

Table 4: Fluorescence Characteristic of Powdered Drug under Ultra-Violet Light

Sl. No.	Treatments	*Capsicum frutescens* L.	
		Colour in day light	Nature of colour in fluorescence
1.	Powder as such	Brick red	Dark brown
2.	Powder with		
3.	Carbon tetra chloride	Reddish orange	Brown
4.	Ethyl acetate	Orange	Reddish brown
5.	Hydrochloric acid	Brown	Brown
6.	Nitric acid + water	Reddish orange	Brown
7.	Sodium hydroxide + methanol	Dark red	Brown
8.	Sodium hydroxide + water	Brownish red	Reddish brown
9.	Sulphuric acid + water	Dark brown	Dark brown
10.	Buffer - pH 5	Red	Reddish brown
11.	Buffer - pH 7	Red	Reddish brown
12.	Buffer - pH 9	Red	Reddish brown

Ultra-Violet Spectroscopy – The data related to Ultra-Violet Spectrophotometric characteristics as computed in Table 5.

Table 5: Ultra-Violet Spectrophotometer characteristic of drugs.

Sl. No.	Specifications	Data
1.	Tincture dilution ml/ml	1
2.	Maximum absorption peak	0.074 0.288
3.	λ Maxima at, nm	268.55 214.30

VI. Chromatographic Profile

Thin-Layer Chromatography – Best separation for TLC fingerprinting were obtained by using different layers and solvent systems. Inferences are shown in Table 6.

Table 6: TLC fingerprinting data

S. No.	Drug	Mobile Phase/ Solvent System	Derivatizing Reagents	Visualizations	No. of Spots	R_f Values of bands
1.	*Capsicum frutescens* L.	Toluene: Ethyl acetate (9:1) v/v	Anisaldehyde-Sulphuric Acid	Under UV 254nm	8	0.07 ,0.14 , 0.25, 0.34, 0.41, 0.48, 0.58 (all grey) and 0.86 (dark grey)
				Under UV 366 nm	5	0.07 (light green), 0.25 (dark grey), 0.41 (greenish yellow), 0.58 (dark grey) and 0.86 (dark grey)
				After derivatization	5	0.05 (violet), 0.34 (dark grey), 0.53, 0.58 (both grey) and 0.86 (dark grey)

Table 7 : Regulatory Specifications for fruits of *C. frutescens* L. in different regulatory compendium.

Sl. No.	Quality Specification	India Pharmacopoeia 55 & 66 Whole Drug	India Pharmacopoeia 55 & 66 Powdered Drug	Food Safety and Standards Regulation 2011 Whole Drug	Food Safety and Standards Regulation 2011 Powdered Drug
	Official Title	Capsicum	Capsicum Powder	Chillies and Capsicum (Lal Mirchi)	Chillies and Capsicum (Lal Mirchi powder)
	Botanical Species	*C. frutescens* L. & *C. annum* L. (Fam. Solanaceae)	*C. frutescens* L. & *C. annum* L. (Fam. Solanaceae)	*C. frutescens* L. & *C. annum* L. (Fam. Solanaceae)	*C. frutescens* L. & *C. annum* L. (Fam. Solanaceae)
	Morphological part/Official part	Dried ripe fruits	Dried ripe fruits	Dried ripe fruits or pods	Powder obtained by grinding, clean, ripe fruits or pods
	Description	I. Macroscopical II. Microscopical	I. Macroscopical	– –	
	Ash	Not more than 8.0 %		–	
	Calyces and pedicels	Not more than 3.0 %		–	
	Foreign organic matter	Not more than 1.0 %		–	
	Non-volatile ether extractive	Not less than 12.0 %		–	
	Mould, Living and dead insects, insect fragments, rodent contamination	–		Free from	Free from

Sl. No.	Quality Specification	India Pharmacopoeia 55 & 66 Whole Drug	India Pharmacopoeia 55 & 66 Powdered Drug	Food Safety and Standards Regulation 2011 Whole Drug	Food Safety and Standards Regulation 2011 Powdered Drug
	Extraneous coloring matter, coating of mineral oil and other harmful substances	--		Free from	Free from
	Extraneous matter	--		Not more than 1.0 % by weight	--
	Unripe and market fruits	--		Not more than 2.0 % by weight	--
	Broken fruits, seeds and fragments	--		Not more than 5.0 % by weight	--
	Moisture	--		Not more than 11.0 % by weight	Not more than 11.0 % by weight
	Total ash on dry basis	--		Not more than 8.0 % by weight	Not more than 8.0 % by weight
	Ash insoluble in dilute HCl on dry basis	--		Not more than 1.3 % by weight	Not more than 1.3 % by weight
	Insect damaged matter	--		Not more than 1.0 % by weight	Not more than 1.0 % by weight
	Crude fibre	--		--	Not more than 30.0 % by weight
	Non-volatile either extract on dry basis	--		--	Not more than 12.0 % by weight

Sl. No.	Quality Specification	India Pharmacopoeia 55 & 66 Whole Drug	India Pharmacopoeia 55 & 66 Powdered Drug	Food Safety and Standards Regulation 2011 Whole Drug	Food Safety and Standards Regulation 2011 Powdered Drug
	Any vegetable oil	--		--	Maximum limit of 2.0 % by weight under a label declaration for the amount and nature of oil used

Discussion

Present communication provides specification of *Capsicum frutescens L*. in respect of macro-morphology, micro-morphology, physico-chemical constants (total ash value, alcohol insoluble, water soluble extractive and alcohol soluble extractive), assay (essential oil limits) and Thin layer chromatography. Food Safety and Standards Regulation 2011 provides limited specification viz. e, insect damaged matter, moisture, extraneous matter, Insect damaged matter, Non-volatile either extract etc. (Table. 7) in respect of dried mature fruits and its powder. Indian Pharmacopoeia (1955 & 1966) also comprises specifications for dried ripe fruit and powder derived from the fruits (Table.8). In the present study pharmacognostic standardization of ripe fruit of *Capsicum frutescens* L. is carried out which can be employed in quality control of *Capsicum frutescens* L. used either as drug or spice or as other commodity in commerce. The monographic profile on *Capsicum frutescens* L. also reviews information on different aspects of drug.

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