**Elettaria cardamomum (L.) Maton**

**Scientific Name:** *Elettaria cardamomum* (L.) Maton  
**Synonyms:** *Amomum cardamomum, Amomum subulatum* Roxb.  
**Family:** Zingiberaceae  
**Genus:** Elettaria  
**Species:** cardamomum  
**Common Name:** Green cardamom, True cardamom, Cardamon, Malabar Cardamom, Elachi

**Parts Used:** Seed

**Plant Description**
The cardamom plant has a tuberous horizontal rhizome, sending up from eight to twenty erect, simple, smooth, green and shining, perennial stems, which rise from six to twelve feet in height, and bear alternate elliptical-lanceolate sheathing leaves. The flower-stalk proceeds from the base of the stem, and lies upon the ground, with the flowers arranged in a panicle. The fruit is a three-celled capsule, containing many seeds; during drying it is said to lose three-fourths of its weight.

**Chemical Constituents**
The seeds contain volatile oil, fixed oil, salt of potassium, a colouring principle, starch, nitrogenous mucilage, ligneous fibre, an acrid resin, and ash. The volatile oil contains terpenes, terpineol and cineol. α-pinene, β-pinene, sabinene, myrcene, α-phellandrene, limonene, 1,8-cineole, γ-terpinene, p-cymene, terpinolene, linalool, linalyl acetate, terpinen-4-oil, α-terpineol, α-terpineol acetate, citronellol, nerol, geraniol, methyl eugenol and trans-nerolidol.

**Action of Herb:** Carminative, stimulant, aromatic, but rarely used alone; chiefly useful as an adjuvant or corrective.

**Medicinal Uses:** The seeds are helpful in indigestion and flatulence. When chewed singly in the mouth the flavor is not unpleasant, and they are said to be good for colic and disorders of the head. Cardamom is used for digestion problems including heartburn, intestinal spasms, irritable bowel syndrome (IBS), intestinal gas, constipation, liver and gallbladder complaints, and loss of appetite. It is also used for common cold, cough, bronchitis, sore mouth and throat, and tendency toward infection. Some people use cardamom as a stimulant and for urinary problems.

**Contraindications**
Pregnancy, lactation and hypersensitivity of cardamom

**Side Effects**
Allergic contact dermatitis, gall stone colic

**Dosages:**
15 to 30 grains of the powdered seeds. Tincture, 1/2 to 1 fluid drachm. Compound tincture, B.P., 1/2 to 1 fluid drachm. Fluid extract, 5 to 30 drops.
Traditionally, the typical dose of cardamom is 1.5 grams of the ground seeds per day. As a digestive, a tea prepared from 1 teaspoon of freshly crushed cardamom seeds infused in 1 cup boiled water for 10-15 minutes has been used.

**Incompatibilities with other medications**

**Interactions with Drugs:** Cardamom may increase the risk of bleeding when taken with drugs that also increase the risk of bleeding. Examples include aspirin, anticoagulants ("blood thinners") such as warfarin (Coumadin®) or heparin, anti-platelet drugs such as clopidogrel (Plavix®), and non-steroidal anti-inflammatory drugs such as ibuprofen (Motrin®, Advil®) or naproxen (Naprosyn®, Aleve®).

Cardamom may interfere with the way the body processes many drugs using the liver's "cytochrome P450" enzyme system. As a result, the levels of these drugs may be increased in the blood in the short-term (causing increased effects or potentially serious adverse reactions), and/or decreased in the blood in the long-term (which can reduce the intended effects). Examples of medications that may be affected by cardamom in this manner include carbamazepine, cyclosporin, irinotecan, midazolam, nifedipine, birth control pills, simvastatin, theophylline, tricyclic antidepressants, warfarin, or HIV drugs such as non-nucleoside reverse transcriptase inhibitors (NNRTIs) or protease inhibitors (PIs).

Cardamom may have antispasmodic effects. Patients taking antispasmodic drugs or muscarinic agents should use with caution. Although not well studied, cardamom may also interact with indomethacin.

**Interactions with Herbs and Dietary Supplements**

Cardamom may increase the risk of bleeding. In theory, this risk may be further increased when cardamom is taken with other herbs or supplements that also increase the risk of bleeding. Multiple cases of bleeding have been reported with the use of *Ginkgo biloba* and two cases with saw palmetto. Numerous other agents may theoretically increase the risk of bleeding, although this has not been proven in most cases.

Cardamom may interfere with the way the body processes certain herbs and supplements using the liver's "cytochrome P450" enzyme system. As a result, the levels of these drugs may be increased in the blood in the short-term, causing increased effects or potentially serious adverse reactions, or decreased in the blood in the long-term, which can reduce the intended effects.

Cardamom may have antispasmodic effects. Patients taking antispasmodic herbs and supplements or muscarinic agents should use with caution.

**Microscopic Examination of *Elettaria cardamomum***

Microscopic examination of *E. cardamomum* powder revealed following microscopic features: reticulate vessel, detached spiral vessel, epidermal layer, oil globule, parenchymatous layer, fragment of endosperm, fiber, spiral vessel attached with cells, arillus layer, pitted vessel, annular vessel, hypodermis layer, pollen grain, spiral vessels, parenchyma filled with calcium oxalate crystals, Sclerenchymatous layer of testaand group of starch grains.
Microscopic Examination of *Elettaria cardamomum*

- Reticulate vessel
- Detached spiral vessel
- Epidermal layer
- Oil globule
- Parenchmatous layer
- Fragment of endosperm
- Spiral vessel attached with cells
- Arillus layer
- Pitted vessel
- Annular vessel
- Parenchymatous cells
- Hypodermis layer
- Pollen grain
- Spiral vessel
- Parenchyma filled with calcium oxalate crystals
Phytochemical analysis of *E. cardamomum*

Tannins, saponins, quinones, phenol, steroids, terpenoids, alkaloids and cardiac glycosides were found present in *E. cardamomum*.

Table: Phytochemical analysis of *E. cardamomum*

<table>
<thead>
<tr>
<th>S. No</th>
<th>Phytochemical/solvents</th>
<th>Ethanol</th>
<th>Acetone</th>
<th>Petroleum ether</th>
<th>Chloroform</th>
<th>Aqueous</th>
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<tbody>
<tr>
<td>1</td>
<td>Tannin</td>
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<td>-</td>
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<tr>
<td>2</td>
<td>Saponin</td>
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<td>+</td>
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<tr>
<td>3</td>
<td>Flavonoids</td>
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<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Quinones</td>
<td>++</td>
<td>+</td>
<td>+</td>
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<td>+</td>
</tr>
<tr>
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<tr>
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<td>Terpenoids</td>
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<tr>
<td>8</td>
<td>Phenols</td>
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<td>+</td>
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<tr>
<td>9</td>
<td>Coumarins</td>
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<td>-</td>
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</tr>
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<td>10</td>
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<td>+</td>
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<tr>
<td>11</td>
<td>Alkaloids</td>
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<td>+</td>
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<tr>
<td>12</td>
<td>Anthocyanin</td>
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<td>-</td>
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<td>-</td>
</tr>
<tr>
<td>13</td>
<td>B-Cyanin</td>
<td>-</td>
<td>-</td>
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</tr>
</tbody>
</table>


High Performance Thin-layer Chromatography of *E. cardamomum*

HPTLC chromatogram of *Elettaria cardamomum* extract and its finished product at 366nm revealed Rf value of 0.21, 0.38 nm.

Figure: HPTLC Chromatogram of *Elettaria cardamomum*
Anti-oxidant activity of *Elettaria cardamomum*

Ethanol, acetone, petroleum ether, chloroform and aqueous extracts of *E. cardamomum* exhibited anti-oxidant activity as shown in graph below.

![Graph: Anti-oxidant activity of *E. cardamomum*](image)


Anti-microbial activity of *E. cardamomum*

Volatile oil obtained from *E. cardamomum* extract exhibited pronounced anti-bacterial activity against *E. coli*, *S. aureus* and *B. subtilis* and anti-fungal activity against *A. niger*, *A. fumigatus*, *A. flavus* and *C. albicans*. The volatile oil showed significant anti-microbial and anti-fungal activity in comparison to standard, Tetracycline and Fluconazole as shown in tables below.

<table>
<thead>
<tr>
<th>Sample conc. (µl/ml)</th>
<th>Zone of inhibition (mm) <em>S. aureus</em></th>
<th>Zone of inhibition (mm) <em>E. coli</em></th>
<th>Zone of inhibition (mm) <em>B. subtilis</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>3 (A)</td>
<td>00</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>5 (B)</td>
<td>00</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>7 (C)</td>
<td>18</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>9 (D)</td>
<td>22</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td>50 (Co)</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>50 (S)</td>
<td>11</td>
<td>16</td>
<td>26</td>
</tr>
</tbody>
</table>


Table: Anti-fungal activity of *E. cardamomum*

<table>
<thead>
<tr>
<th>Sample conc. (µl/ml)</th>
<th>Zone of inhibition (mm) <em>A. niger</em></th>
<th>Zone of inhibition (mm) <em>A. fumigatus</em></th>
<th>Zone of inhibition (mm) <em>A. flavus</em></th>
<th>Zone of inhibition (mm) <em>C. albicans</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>3 (A)</td>
<td>00</td>
<td>11</td>
<td>00</td>
<td>12</td>
</tr>
<tr>
<td>5 (B)</td>
<td>13</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>7 (C)</td>
<td>20</td>
<td>13</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>9 (D)</td>
<td>20</td>
<td>10</td>
<td>21</td>
<td>15</td>
</tr>
<tr>
<td>50 (Co)</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>50 (S)</td>
<td>22</td>
<td>12</td>
<td>14</td>
<td>30</td>
</tr>
</tbody>
</table>

Qualitative analysis of phenolic compounds isolated from *Elettaria cardamomum*

Preliminary qualitative analysis of phenols isolated from *E. cardamomum* is shown in table below.

<table>
<thead>
<tr>
<th>Reagents</th>
<th>Detection result</th>
<th>Indications</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>FeCl3 (1%)</td>
<td>-</td>
<td>Formation of bluish-green colour</td>
<td>Presence of phenolic compounds</td>
</tr>
<tr>
<td>Alcoholic KOH (5N)</td>
<td>-</td>
<td>Formation of yellow precipitate</td>
<td>Presence of flavonoids</td>
</tr>
<tr>
<td>Pb (Ac)2</td>
<td>-</td>
<td>Formation of brown-white precipitate</td>
<td>Presence of tannins</td>
</tr>
<tr>
<td>Molish</td>
<td>-</td>
<td>No violet colour</td>
<td>No carbohydrates</td>
</tr>
<tr>
<td>Benedicts</td>
<td>-</td>
<td>No red precipitate</td>
<td>No glycosides</td>
</tr>
<tr>
<td>Ninhydrin (1%)</td>
<td>-</td>
<td>No violet colour</td>
<td>No amino acids</td>
</tr>
<tr>
<td>HgCl2</td>
<td>-</td>
<td>No white precipitate</td>
<td>No saponins</td>
</tr>
<tr>
<td>Dragendorff</td>
<td>-</td>
<td>No orange precipitate</td>
<td>No alkaloids</td>
</tr>
</tbody>
</table>


**Fourier Transform Infra-red Spectroscopy of *Elettaria cardamomum***

FT-IR spectra of *E. cardamomum* revealed following prominent peaks: O-H, C-H, C=O, C=C, C-O, Ar-X.

**Hepato-protective activity of Elettaria cardamomum**

Ethanolic extract of *E. cardamomum* revealed no sign of toxicity and toxicity up to 2000mg/kg dose.

![Liver tissue treated with 100 mg/kg of Elettaria cardamomum](image1)

![Liver tissue treated with 200 mg/kg of Elettaria cardamomum](image2)

![Liver tissue treated with 400 mg/kg of Elettaria cardamomum](image3)


**Allergic effects**

Patch test reactions to cinnamic aldehyde were found in 11/25 factory workers, but in several cases, the nature of the reactions was difficult to evaluate. Irritant patch test reactions were seen from powders of cardamom, paprika and white pepper. On prick testing, 6/25 workers reacted to cinnamic aldehyde. The results illustrate the difficulties of patch testing with spices and indicate the need for further research and validation of methods. Chronic contact dermatitis has occurred.
with repeated exposure to cardamom. In a case report, the patient had positive patch test reactions to cardamom and certain terpenoid compounds present in the dried ripe seeds of cardamom.

**Analgesic effects:** An investigation of the analgesic activity of the oil extracted from commercial *E. cardamomum* seeds using p-benzoquinone as a chemical stimulus proved that a dose of 233µL/kg of the oil produced 50% protection against the writhing (stretching syndrome) induced by intraperitoneal administration of a 0.02% solution of p-benzoquinone in mice.

**Anti-cancer:** Male Swiss albino mice were injected with Azoxymethane (AOM) (dose: 5mg/kg body weight) or saline (Group 1) weekly once for two weeks. The AOM-injected mice were randomly assigned to two groups (Groups 2 and 3). While all the groups were on standard lab chow, Group 3 received oral doses of 0.5% cardamom, in aqueous suspension, daily for 8 weeks. Following treatment, significant reduction in the incidences of aberrant crypt foci (p<0.05) was observed. This reduction in aberrant crypt foci (ACF) was accompanied by suppression of cell proliferation (mean Brdu LI in carcinogen control=13.91+/-3.31, and 0.5% cardamom=2.723+/-0.830) and induction of apoptosis (mean AI in carcinogen control=1.547+/-0.42 and 0.5% cardamom=6.61+/-0.55). Moreover, reduction of both cyclooxygenase-2 (COX-2) and inducible nitric oxide synthase (iNOS) expression was also observed. These results suggest that aqueous suspensions of cardamom have protective effects on experimentally induced colon carcinogenesis.

Essential oil from cardamom was tested for its ability to suppress the formation of DNA adducts by aflatoxin B1 in vitro in a microsomal enzyme-mediated reaction. The oil was found to inhibit adduct formation very significantly and in a dose-dependent manner. The adduct formation appeared to be modulated through the action on microsomal enzymes, because an effective inhibition on the formation of activated metabolite was observed with the oil. The enzymatic modulation is perhaps due to the chemical constituents of the oil, and this could form a basis for their potential anti-carcinogenic roles.

**Anti-inflammatory effects:** Cardamom oil produced the maximum (10x) *in vitro* permeation enhancement for ion-paired diclofenac sodium (DS). The carrageenan induced rat paw edema reduction (up to 12 hours) by cardamom oil was comparable to that of diclofenac subcutaneous injection. Leaching of cholesterol from excised skin in addition to increased partition coefficient following volatile oil skin pretreatment appears to be responsible for *in vitro* permeation enhancement of DS. Whereas, a mild barrier perturbation effect due to altered cholesterol levels following pretreatment with volatile oils appears to increase the permeation of ion-paired DS across viable skin, thereby producing significant reduction of carrageenan induced paw edema. A comparative study of the anti-inflammatory activity of the oil extracted from commercial *E. cardamomum* seeds, in doses of 175 and 280microL/kg and indomethacin in a dose of 30mg/kg against acute carrageenan-induced planter edema in male albino rats was performed, which proved to be marked.

**Anti-microbial effects:** Inhibition of growth was tested by the paper disc agar diffusion method. Antibiotic susceptibility discs were used as control. Minimum lethal concentration (MLC) was determined by the tube dilution method. Essential oil from cardamom was evaluated to have some inhibition for each of the test strains that included: *Listeria monocytogenes, Staphylococcus aureus, Escherichia coli O: 157: H7, Yersinia enterocolitica, Pseudomonas aeruginosa, Lactobacillus plantarum, Aspergillus niger, Geotrichum, and Rhodotorula.*
Five prepackaged samples of cardamom powder were selected from supermarkets and ethnic shops in Lisbon (Portugal) for estimation of aflatoxins by immunoaffinity column clean-up followed by HPLC. Aflatoxin B1 (AFB1), B2, G1 and G2 were not detected.

**Antioxidant effects:** Cardamom has medium levels (50-100mg) of antioxidant phenolics and flavonoids. Total phenolics were measured biochemically and flavonoids were measured as a sum of quercetin, kaempferol, luteolin and pelargonidin. Cardamom extracts have also been found to be pro-oxidants. In order to gain insight into the antioxidant effect of cardamom (*Amomum subulatum*) hepatic and cardiac antioxidant enzymes, glutathione (GSH) content and lipid conjugated dienes were studied in rats fed high fat diet along with cardamom. The antioxidant enzyme activities were found to be significantly enhanced whereas GSH content was markedly restored in rats fed a fat diet with cardamom. In addition, cardamom partially counteracted increase in lipid conjugated dienes and hydroperoxides, the primary products of lipid peroxidation. Thus, it appears that cardamom exerts antioxidant protection through its ability to activate the antioxidant enzymes.

**Anti-spasmotic effects**
The antispasmodic activity of the oil extracted from commercial *E. cardamomum* seeds was determined on a rabbit intestine preparation using acetylcholine as agonist, the results proving that cardamom oil exerts its antispasmodic action through muscarinic receptor blockage.

**Anti-ulcer effects**
The crude methanolic extract of *A. subulatum* and its fractions, viz. essential oil, petroleum ether and ethyl acetate, inhibited gastric lesions in rats induced by ethanol significantly, but not those which were induced by pylorus ligation and aspirin. However, ethyl acetate fraction increased the wall mucus in pylorus ligated rats. The results suggest a direct protective effect of ethyl acetate fraction on gastric mucosal barrier. While the observation of decrease in gastric motility by essential oil and a petroleum ether fraction suggests the gastroprotective action of the test drug. In a similar experiment using *E. cardamomum* Maton., all fractions significantly inhibited gastric lesions induced by ethanol and aspirin but not those induced by pylorus ligation. In the aspirin-induced gastric ulcer, the best gastroprotective effect was found in the petroleum ether soluble fraction, which inhibited lesions by nearly 100% at 12.5mg/kg. The petroleum ether soluble extract at doses \(>12.5\)mg/kg proved to be more active than ranitidine at 50mg/kg. Cardamom may somewhat increase gastric acid secretion.

**Dermatological effects**
The *in vitro* and *in vivo* effect of pretreatment by cardamom oil, a crude drug extract, in ethanol/water vehicles on the transdermal delivery of indomethacin was investigated. The cyclic monoterpene components in cardamom oil were also determined and quantified in this study. The permeation of indomethacin was significantly enhanced after pretreatment of cardamom oil both in the *in vitro* and *in vivo* studies. The result of various pre-treatment periods showed that the indomethacin flux decreased as the length of the pretreatment increased. Both natural cardamom oil and a cyclic monoterpene mixture composed of the components of the oil showed similar enhancement on indomethacin permeation, indicating cyclic monoterpenes are the predominant components altering the barrier property of stratum corneum. The results also showed that three minor components in cardamom oil (alpha-pinene, 6.5%; beta-pinene, 4.8%; alpha-terpineol, 0.4%) had a synergistic effect with 1,8-cineole (59.3%) and d-limonene (29.0%) to enhance the permeation of indomethacin. A synergistic effect on drug permeation was observed when transdermal iontophoresis combined with the pretreatment of cardamom oil as a permeation enhancer.
Food preservation effects
Cardamom exhibited a moderate effect in the minimization of the formation of toxic histamine in mackerel.

Genotoxic effects
Cytogenetic studies in Chinese hamster ovary (CHO) cells using aqueous and organic extracts of pan masalas, as well as genomic damage observed among pan masala consumers have conclusively shown genotoxic potential of pan masala, a dry complex mixture contains areca nut, lime, catechu, cardamom, and often containing tobacco. Due to the multiple ingredients in pan masala, the effects specific to cardamom are difficult to extract.

Pan masala (without tobacco) is a dried powdered mixture containing ingredients like areca nut, catechu, lime, cardamom and flavoring agents. In view of the role of the ingredients of pan masala in the causation of oral diseases, the possible harmful effects of consuming this complex mixture were analyzed in individuals regularly consuming pan masala and among healthy non-consuming controls without any habit. Three cytogenetic endpoints and two tissues were employed to assess possible DNA damage. Sister chromatid exchange and chromosome aberrations were estimated in the peripheral blood lymphocytes, tissues indirectly exposed to the substance and the frequency of micronucleated cells was scored in the tissue directly in contact with pan masala, i.e. the exfoliated buccal mucosa cells. All three cytogenetic endpoints demonstrated a statistically significant increase (p<0.001) among the pan masala consumers as compared with the non-consuming controls. Because pan masala is a combination of several ingredients, the effects specific to cardamom cannot be extracted from this study.

Hepatic effects
The influence of cardamom essential oil on the activities of hepatic carcinogen-metabolizing enzymes (cytochrome P450, aryl hydrocarbon hydrolase, and glutathione S-transferase) and acid-soluble sulfhydryl level was investigated in Swiss albino mice. The oil was fed by gavage at 10 microL per day for 14 days, and then the animals were sacrificed and their hepatic enzyme activities and sulfhydryl levels were evaluated. Cardamom oil caused a significant reduction in cytochrome P450 level activity (p<0.05).

Platelet aggregation effects
An increase in concentration of cardamom has decreased malondialdehyde formation significantly. The aqueous extract of cardamom may have components, which protect platelets from aggregation and lipid peroxidation.

Bronchodilatory effect
Crude extract of cardamom at the doses of 10, 30 and 100 mg/kg caused 9 ± 2.1, 37.7 ± 5.4 and 83.4 ±4.4% (n=4) respective inhibition of carbachol (1 μmol/kg) evoked increase in inspiratory pressure of anesthetized rats. Salbutamol suppressed the carbachol (1 μmol/kg) induced bronchoconstriction at 0.3 mg/kg by 78.7 ± 3.9%. Cardamom inhibits carbachol-evoked bronchospasm the way caused by a standard bronchodilator, Salbutamol.

References


Elettaria cardamomum - Köhler’s Medizinal-Pflanzen - Franz Eugen Köhler, Köhler’s Medizinal-Pflanzen.


SERNA/Guaymuras, Tegucigalpa, Honduras.
Parthasarathy VA, Chempakam B, Zachariah TJ, Sindu S. Book of spices.