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Cardamom: Chemistry, Medicinal Properties, Applications in Dairy and Food Industry: A Review

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Abstract

Cardamom is popularly known as 'Queen of Spices' due to its pleasant aroma and taste. It is widely used in India since ancient times. Cardamom contains steam-volatile oil, fixed oil, pigments, proteins, cellulose, pentosans, sugars, starch, silica, calcium oxalate and minerals. The aroma and flavor of cardamom are obtained from the essential oils which are composed of mainly α-terpinyl acetate and 1,8-cineole. Cardamom has excellent medicinal properties such as antiseptic, carminative, digestive, diuretic, stimulant, stomachic, tonic and antispasmodic, antimicrobial and anti-inflammatory activities. Mainly three forms of cardamom viz. whole, decorticated seeds, and fully ground into powder are used as flavoring agent in dairy and food industry. Cardamom is used in preparation of sweets, milk and milk products (like khoa, gulabjamun, sandesh, basundi, etc.), bakery products, cakes, bread, flavored pickles, rice and meat preparations, alcoholic and nonalcoholic beverages, frozen desserts, candies, puddings, condiments, relishes, gravies, etc.

Keywords: *Cardamom, essential oils, flavoring agent, medicinal properties*

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INTRODUCTION

Cardamom, belonging to the family of *Zingiberaceae*, is obtained from the seeds of *Elettaria cardamomum* Maton and it is mostly cultivated in southern India, Sri Lanka, Tanzania and Guatemala [1]. The genus consists of about six species [2]. Only *E. cardamomum* Maton occurs in India and this is the only economically important species. It is highly valued from ancient times, because of its very pleasant aroma and taste and it referred as the 'Queen of Spices'. The major use of cardamom is culinary purpose for flavoring food. It is also used in medicine as an aromatic stimulant, carminative and flavoring agent. Cardamom was used by ancient Greeks and Romans and also recommended by the Apicius, a famous Roman empire to counteract over indulgence [3]. There are two kinds of cardamoms found in the spice world: (i) Small cardamom-popularly known as Chhota Elaichi (*Elettaria cardamomum*) or the true cardamom and (ii) large cardamom – Bada Elaichi (*Aframomum* and *Amomum* species). Cardamom is often named as the third most expensive spice in the world (after saffron and vanilla) [4]. *Mysore, Malabar, Ceylon, Vazhukka, Manjarabad, Bijapur, Kunnielam, Makaraelam, Thara Guatemala* and *Nanda* are the varieties of cardamom which are grown and cultivated in different parts of India. Among all these, *Mysore*, *Malabar* and *Vazhukka* are most popular cultivated varieties of cardamom and which can be identified on the basis of morphological characteristics [5].

Small cardamom is grown mainly in the Western Ghats of Kerala, Karnataka, and Tamil Nadu. Majority of cardamom holdings are small and marginal. The total area under small cardamom during 2016–17 was 52,820 hectares with and estimated production of 19,625 metric tonnes. Large cardamom is mainly grown in the sub-Himalayan tracts of Sikkim, Arunachal Pradesh, Nagaland and Darjeeling districts of West Bengal. The total area under large cardamom in Sikkim and

Darjeeling districts of West Bengal during 2016–17 was 26,787 ha with an estimated production of 5,623 tonnes [6].

HISTORY

Ancient Sanskrit texts, the Indus valley excavations, the discoveries of archeological surveys of the Egyptian pyramids, the *Dravidian Sangam* literature, the well documented works of Greek historians, the *Ayurvedic* texts of *Susruta* and *Characa*, and the more modern memoirs of the adventurers from Europe clearly establish the significant part spices have played in the development of civilization-the life of people and trade among the nations of the East and West. Spices, such as ginger, pepper, and turmeric, which have an intense impact on sensory perception and exhibit stronger physiological effects, have been widely described in the ancient texts on food and medicine [7]. The genius of the early civilization in India and Southeast Asia is clear from the careful selection and collection of these aromatic and pungent spices from wild growth in tropical forests and their utilization both for flavoring of food and as specifics for many common ailments. The significance of these practices was quickly absorbed by the Greek and Roman civilizations, though these spices and herbs were used initially to make the insipid and deteriorating stored foods more acceptable and to ward off diseases during epidemics. Though there is mention of cardamom in the ancient Greek literature of a few centuries BC, it is not clear if they refer to the true cardamom of the present international trade or to *Amomum*, the large or false cardamoms from related species, presently of purely local interest in the areas where they are traditionally collected or grown [8].

Cardamom is used in India from ancient times. Ancient literature mention the use of cardamom and it is known as *Ela* in Sanskrit. *Taitreya Samhita*, which belongs to the later Vedic period (3000 BC), contains mention of cardamom among the ingredients to be poured in the sacrificial fire on the occasion of a marriage ceremony [9]. The ancient Indian Ayurvedic texts, *Charaka Samhita* and *Susrutha Samhita*, (1400–600 BC) mentioned cardamom on many occasions. According to the ancient literature, cardamom grew in the gardens of the King of Babylon in 720 BC. The ancient Egyptians chewed cardamoms to whiten their teeth and at the same time to sweeten their breath. The Indian Ayurvedic medicine during 4 BC used the spice to remove fat and to treat urinary and skin complaints. Ancient Greeks and Romans used cardamom in perfumes [10].

BOTANICAL DESCRIPTION

Perennial herbaceous plants of considerable height, with creeping rootstock and two distinct aerial growths, the leaf and flower shoots. Leaves are arranged in two rows with long sheath, mostly without stalk and an undivided lanceolate leaf blade; they are dark green in color, either glabrous or pubescent. Inflorescence is a panicle of head like spike with many or few flowers. Each flower is in the aril of a subtending leaf and with a laterally situated bract. The flower is longitudinally bearing, with long-tubed outer calyx and inner corrella ending in strikingly colored lobes, one of which is helmet-shaped. The staminodium, called the "lip" or "labellum", is lightly colored and is the more strikingly attractive device of the flower for attracting pollinating insects. The fruit-node is inferior and trilocular. Each cell contains double-rowed, centrally angled, inverted ovules. The thread like stylus on the fruit-node is funnel-shaped with nectar glands at the bottom. The fruit is a three-compartmentalized dehiscent berry with a leathery, fleshy, or juicy texture; and the compartments are packed with angled or ellipsoidal wrinkled seeds. In the genus *Elettaria*, the flowers are on long-stalked panicles and made up of multiflowered spirals. Flowers are about 30 to 35 mm long, white or pale green, with the central lip streaked blue or violet. Fruits are ellipsoidal or almost spherical, nondehiscent, fleshy when green, and leathery when dry. The genus *Amomum* is differentiated from *Elettaria* in having short-stalked or sensile flowers in a thickly-flowered, conically shaped spike; lateral staminodia are thin or absent. The fruits grow in loose or dense clusters, and are thick fleshed which, on drying, forms a leathery fruit coat. Fruits are three-chambered, filled with many seeds, and dehiscent [11].

The color of the dry capsule is green, greenish yellow, yellow, or pale brown. A small portion of the produce is marketed in a bleached, creamy white form. The dry capsule is three-sided, ovoid or longish with clearly recognizable longitudinal ridge lines and beaklike tip. The length varies from 7 to 15 mm, depending on variety, area of growth, maturity at harvest, and drying conditions. The three chambers of the capsules are partitioned by thin membranes and packed with clumps of six to eight reddish brown to dark brown seeds, each covered by a paper-thin aril. The seeds are conical, irregular bodies with a rounded base. They are about 3 mm long and have a slightly wrinkled surface. The husk is about 1 mm thick and consists of two or three layers of obliterated thin walled cells making up the outer epidermis and the inner wall sandwiching a thick layer of thin parenchymal cells of irregular elliptic shape. Each cell in the parenchyma contains one or more calcium oxalate crystals. Fibrovascular and fibrous bundles and roundish oil-resin cells are found scattered in the parenchyma." The husk is fibrous and tough and has little aroma [12].

CHEMICAL COMPOSITION OF CARDAMOM

Dried fruit of cardamom contains steam-volatile oil, fixed (fatty) oil, pigments, proteins, cellulose, pentosans, sugars, starch, silica, calcium oxalate and minerals. The major constituent of the seed is starch (up to 50 per cent) while in the fruit husk it is crude fiber (up to 31 per cent). Volatile oil is the most functionally important constituent of cardamom. The volatile oil content of seeds varies from 6.5 to 10.5% for the two types of cardamom (Malabar and Mysore) grown in India. In immature capsules, obtained in small quantities in all harvests (and more particularly in the last harvest), the volatile oil content is low, on the order of 4 to 5% [13]. Cardamom contains 2.8–6.2% volatile oil, 10% protein, 1–10% fixed oil and up to 50% starch. The aroma and flavor of cardamom are obtained from the essential oils which is composed of mainly α-terpinyl acetate (20–55%) and 1,8-cineole (20–60%) which are responsible for specific flavor to the cardamom [14, 15]. The physical and chemical quality of cardamom is shown in Table 1.

The essential oil in the seeds contain α-terpineol 45%, myrcene 27%, limonene 8%, menthone 6%, ß-phellandrene 3%, 1,8-cineol 2%, sabinene 2% and heptane 2%. Compositions of oils vary, depending on types, (e.g., Mysore and Malabar). Minor component present in cardamom essential oil include limonene, sabinene, linalool, linalyl acetate, α-pinene, α-terpineol, camphene, myrcene, 1,4-cineole, borneol, and others. Acetic, butyric, decanoic, dodecanoic, citronellic, geranic, hexanoic, heptanoic, nerylic, and perillic acids are acids present in essential oil of cardamom while waxes containing n-alkanes and sterols, including β-sitostenone, stigmasterol, and β-sitosterol are in fixed oil. The main factor that determines the quality of cardamom is the content and composition of volatile oil, which governs the odor and flavor [16].

Low content of cineole and high content of terpinyl acetate are considered to be of superior quality oil for flavor applications. Cardamom is rich in vitamin C, thiamine, riboflavin, niacin, vitamin B_6, zinc, copper, iron, sodium, manganese, potassium, calcium, magnesium, phosphorus, respectively. The chemical composition of cardamom varies with variety, region and age of the product. The content of volatile oil in the seeds is strongly dependant on storage conditions, but may be as high as 8 per cent. The oil has few mono or hydrocarbons and is dominated by oxygenated compounds, all of which are potential aroma compounds [11, 17–19]. Volatile oil from cardamom (*E.cardamomum Maton* var. *Minisula Barhill*) contains few hydrocarbons and large amounts of 1,8-cineole and α-cineole and α-terpinyl acetate, while that from *E. cardamomum Maton* var, *major Thewaites* (the Ceylon wild cardamom) is high in monoterpenes and very poor in the above two oxygenated compounds. The oils from the *Ammomum* species are all much higher in 1,8-cineole, around 60 to 75%, and some have relatively large amounts of comphor and borneol [19]. The FSSAI and Agmark standards of cardamom are shown in Table 2 and Table 3 respectively.

Table 1: *Physical and Chemical Quality of Cardamom [20].*

Physical Parameter	**Cardamom**	**Chemical parameter (%)**	**Cardamom**
Weight of 100 capsules (g)	12.18–24.26	Moisture	5.08–18.8
No. of capsules in 100 g	334–807	Oil	10–14
Weight of splits (in 100 g)	6.80–21.46	Starch	29.5–39.3
Seed husk ratio	3:1	Carbohydrate	31.75–40.16
Bulk density (g/l)	286.72–384.64	Reducing sugar	3.14–3.17
Color intensity (hue-lightness)	23–13 to 24–8	Phenols	3.26–4.75
Circumference of capsules (cm)	2.0–2.46	Protein	1.03–1.42
Length of capsules (cm)	1.60–1.89	Crude fibre	12.2–16.3
		Ash	7.45–8.60
		Acid insoluble ash	1.07–1.76

Table 2: *FSSAI Standards of Cardamom.*

Parameter	**Small cardamom**			**Large cardamom**		
	Whole	*Seed*	*Powder*	*Whole*	*Seed*	*Powder*
Extraneous matter (by wt.) Max.	1.0%	2.0%	-	1.0%	2.0%	-
Empty and malformed capsules (by count) Max.	3.0%	-	-	2.0%	-	-
Immature and shrivelled capsules (by wt.) Max.	3.0%	-	-	2.0%	-	-
Moisture (by wt.) Max.	13.0%	13.0%	11.0%	12.0%	12.0%	11.0%
Total ash on dry basis (by wt.) Max.	9.5%	9.5%	8.0%	8.0%	8.0%	8.0%
Volatile oil content on dry basis (by v/w) Min.	3.5%	3.5%	3.0%	1.0%	1.0%	1.0%
Insect damaged matter (by wt.) Max.	1.0%	1.0%	-	1.0%	1.0%	-
Light seeds/ Brown / Red seeds (by wt.) Max.	-	3.0%	-	-	3.0%	-
Ash insoluble in dilute HCl (on dry basis) Max.	-	-	3.0%	2.0%	2.0%	2.0%

Table 3: *Agmark Standards of Cardamom.*

Parameter	**Small cardamom**						**Large cardamom**					
	Whole		*Seed*		*Powder*		*Whole*		*Seed*		*Powder*	
	Sp.	*Std.*	*Sp.*	*Std.*	*Sp.*	*Std.*	*Sp.*	*Std.*	*Sp.*	*Std.*	*Sp.*	*Std.*
Organic extraneous matter % (m/m) (Max.)	1.0	2.0	0.5	1.5	-	-	0.8	4.0	0.5	1.0	-	-
Light seeds % (m/m) (Max.)	-	-	2.0	5.0	-	-	-	-	5.0	5.0	-	-
Insect damaged seeds, % (m/m) (Max.)	-	-	-	-	-	-	-	-	Nil	3.0	-	-
Inorganic extraneous matter % (m/m) (Max.)	0.5	1.0	-	-	-	-	0.2	1.0	-	-	-	-
Empty and malformed capsules per cent by count (Max.)	2.0	5.0	-	-	-	-	5.0	8.0	-	-	-	-
Immature and shrivelled capsules % (m/m) (Max.)	2.0	5.0	-	-	-	-	3.0	5.0	-	-	-	-
Blacks and splits per cent by count (Max.)	Nil	10.0	-	-	-	-	-	-	-	-	-	-
Mass in g/l (Min.)	435	385	675	625	-	-	350	300	-	-	-	-
Moisture % (m/m) (Max.)	11.0	12.0	11.0	13.0	11.0	13.0	12.0	12.0	12.0	12.0	10.0	12.0
Total ash % (m/m) (Max.)	8.0	9.5	7.0	8.0	7.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Volatile oil % (ml/100 g) (Min.)	3.5	3.0	3.5	3.0	3.5	3.0	2.0	1.0	2.0	1.0	1.5	1.0
Acid insoluble ash, % (m/m) (Max.)	-	-	-	-	2.5	3.0	2.0	2.0	2.0	2.0	2.0	3.0
Crude fibre % (m/m) (Max.)	-	-	-	-	10.0	12.0	-	-	-	-	12.0	15.0
Nonvolatile ether extract, % (m/m) (Min.)	-	-	-	-	-	-	-	-	-	-	4.0	2.0

MEDICINAL PROPERTIES

The major medicinal properties of cardamom essential oil are its antiseptic, carminative, digestive, diuretic, stimulant, stomachic, tonic

and antispasmodic, antimicrobial and anti-inflammatory activities. It has been used to treat bronchitis, haemorrhoids, stangury, renal and vesical calculi, anorexia, dyspepsia and gastropathy [21].

According to Ayurveda cardamom is used against heart disease, kidney disease, urinary disease, bacterial infection, teeth infection, pulmonary tuberculosis, asthma, food poisoning, eyelid inflammation, digestive disorders, sore throats, colds, bladder disease, snake bite, scorpion bite, and constipation [22]. Cardamom seeds are used as aromatic, acrid, sweet, cooling, carminative abortifacient, alexiteric, cardiac tonic, digestive, diuretic, expectorant, stimulant, and tonic. Cardamom seeds are also give beneficial effect in anorexia, dyspepsia, asthma, bronchitis, strangury, haemorrhoids, renal and vesical calculi, halitosis, gastropathy and burning sensation [23].

Anti-microbial and Anti-cancer Activity

Ethanolic extract of *E. cardamomum* possess antibacterial effect at the dose of 512 μg/mL. The terpenoid constituents are responsible for the antifungal and anitbacterial effects. Kaur et al. (2013) [24] found that black cardamom extracts show *in vitro* antibacterial, anticancer as well as immunomodulatory activity. The methanol, ethanol and acetone extracts of black cardamom were effective against gram positive and gram negative bacteria such as *Pseudomonas aeruginosa, Bacillus cereus, Escherichia coli and Staphylococcus aureus.* Results showed that minimum inhibitory concentration mostly at 5 and 10 mg/ml of different black cardamom extracts. Black cardamom also showed anticancer activity against MCF-7 (Michigan Cancer Foundation-7) breast cancer cell. 500 μg/ml is the optimum concentration which inhibits MCF-7 cells maximally. The flavor components also showed antibacterial effects against several food-born microorganisms (Kubo et al. 1991). Agaoglu et al. (2006) [25] showed antimicrobial effects of seed extract of cardamom (*Elettaria cardamomum* Maton) against *Pseudomonas aeruginosa, Mycobacterium smegmatis, Klebsiella pneumoniae, Staphylococcus aureus, Escherichia coli, Salmonella typhimurium, Enterococcus faecalis, Micrococcus luteus and Candida albicans*.

Anti-Inflammatory Activity

Al-Zuhair et al. (1996) [26] have shown that cardamom oil administered at 175 and 280 μl/kg of body weight inhibited the growth of carrageenan-induced paw edema in rats by 69.2% and 86.4%, respectively. The anti-inflammatory activity of cardamom oil is comparable to that of indomethacin (indometacin).

Anti-ulcerogenic Activity

The petroleum ether soluble extract from *Elettaria cardamomum* seeds was screened for aspirin-induced anti-ulcerogenic activity in rats. The petroleum ether soluble extract inhibited lesions by nearly 100% at 12.5 mg/kg [27].

Skin-penetration Enhancing Activity

The essential oils have good skin permeation activity for certain drugs. Distract the structural order of the skin and thus increasing the diffusion capacity of the active components by the lipid intercellular pathway, due to interaction of oils with the lipids of the horny layer of the skin. An *in vitro* study on the permeation of estradiol through hairless mouse skin was studied by Monti et al. (2002) [28], studies show that complex terpenes are responsible for the enhancement of transdermal permeation for moderately lipophilic drugs like estradiol. Permeation of indomethacin showed that permeation was significantly enhanced after pretreatment with cardamom oil, due to the presence of cyclic monoterpenes from *Elettaria cardamomum* [29].

Gastroprotective Activity

Petroleum ether soluble extract of *E. cardamomum* found gastroprotective activity, which inhibited lesions by nearly 100% at 12.5 mg/kg in the aspirin-induced gastric ulcer. Methanolic extract also possess gastroprotective effect [27].

Blood Pressure Lowering Activity
Powdered *E. Cardamomum* possess antihypertensive activity. At a dose of 3 g, it significantly decreases diastolic pressure. In hypertensive patients, without significantly altering blood lipids and fibrinogen level, cardamom enhances fibrinolysis and improves antioxidant status [30].

Cigarette De addiction
Cardamom is used against cigarette addiction. Smoking of cigarette can be minimized by eating few seeds of cardamom and slowly the smoker may give up the chronic addiction to chain smoking [31].

Oral Health
Due to its antiseptic and antimicrobial properties, essential oils are very useful in oral health. If used as a mouth wash by adding few drops of this oil in water, it disinfects the oral cavity of all germs [32].

Digestive and Stomachic
Cardamom is good digestive due to essential oil. Whole digestive system is stimulating by cardamom essential oil. Essential oil has stomachic in nature, which keeps the stomach healthy and functioning properly. Proper secretion of gastric juices, acids and bile in the stomach is maintained by this oil [33].

Stimulant
Essential oil of cardamom stimulates our entire system. In cases of depression or fatigue, essential oil boosts our spirits. It maintains proper metabolic action throughout the body by stimulating the secretion of various enzymes and hormones, gastric juices, peristaltic motion, circulation, and excretion. It protects the stomach from infections [33].

USES OF CARDAMOM

Cardamom is a highly-flavored spice and is used mainly in the preparation of sweets, bakery products, flavored pickles, rice and meat preparations. In processed foods, cardamom flavor is incorporated in the form of essential oil or the solvent extracted cardamom oleoresin [11, 19]. Cardamom is used for culinary purposes in curry, coffee, cakes, and bread, and for flavoring sweet dishes and drinks. The seeds and the essential oil are used as a flavoring component in a variety of foods, including alcoholic and nonalcoholic beverages, frozen desserts, candies, baked goods, puddings, condiments, relishes, gravies, meat, and meat products. It is used as a spice in Moroccan tajines, and is generally used widely in cooking, including that of meats. Cardamom is also utilized in traditional Chinese and Indian medicine as a digestive aid, and for the treatment of flatulence. It is added to massage oils and lotions, as well as soaps, detergents, and perfumes, because of its soothing properties [34].

Use in Dairy and Food Industry
Sen and Rajorhia (1996) [35] incorporated ground cardamom seeds at 0.05, 0.10 and 0.15 per cent by weight of *channa* in the last stage of soft sandesh production and packaged it aseptically in pre sterilized lacquered tin cans. Sandesh sample treated with 0.1 per cent cardamom remained acceptable for upto 24 days at 30ºC and 85 days at 7ºC as compared to 4 and 47 days, respectively for control sandesh. Kober et al. (2003) [36] worked on effects of cardamom on shelf life of sandesh at room temperature. Cardamom powder was mixed at the rate of 0, 0.05, 0.10 and 0.15 per cent with each part of *chhana* at the last stage of making sandesh. Chemical constituents of different samples showed significant variation with the advancement of storage period. The control samples were suitable for consumption up to 12 days, while addition of cardamom powder (0.05, 0.10 and 0.15 per cent) extended the storage life up to 20, 24 and 28 days at room temperature, respectively.

Narwade (2003) [37] found that addition of cardamom @ 0.2 per cent and nutmeg @ 0.3 per cent were the most optimum level in *pedha* with good sensory acceptability score. Ahire (2007) [38] studied effect of herbal preservatives on the shelf-life of *pedha*. The control sample was acceptable up to 10 days in HDPE while in multilayer film it was acceptable up to 12 days of storage. The carmdamom treated pedha sample was acceptable up to 12 days of storage in HDPE while in multilayer film, it was acceptable up to 14th day of storage. Chougule et al. (2014) [39] studied the sensory quality of Basundi

prepared by using cardamom and saffron. Use of 0.4 per cent cardamom level was organoleptically most acceptable in respect to all sensory attributes.

Dandile et al. (2014) [40] studied sensory quality of Shrikhand prepared by using cardamom and saffron. The Shrikhand prepared by 0.020 per cent saffron and 0.50 per cent cardamom and 40 per cent sugar was superior in the color and appearance, body and texture, flavor and overall acceptability. Abdelatti et al. (2015) [41] studied the effect of adding some herbs on the shelf life of camel milk. The 0.05 g of anise (*Pimpinella ansium*), cardamom (*Elettaria cardamoum*) and spearmint (*Mentha spicata*) were added in milk. In sensory evaluation milk treated with anise or cardamom showed higher acceptability and good flavor up to 10 days. Lad et al. (2017) [42] prepared gulabjamun from camel milk khoa. He found some objectionable off flavor in gulabjamun when prepared from camel milk khoa. This flavor was successfully masked by adding cardamom in dough as well as sugar syrup. For this, cardamom extract was prepared by adding 1 g of cardamom in 20 ml water and this was used for 125 g formulation of gulabjamun along with 54 °Brix sugar syrup as an extract of cardamom (3 g per litre) for soaking the gulabjamun from camel milk khoa can be successfully masked objectionable flavor. Patil (2017) [43] studied process standardization for the manufacture of saffron (*Crocus sativus*) and cardamom (*Elettaria cardamomum*) flavored misti dahi using buffalo milk. Misti dahi was prepared from buffalo milk using 0, 2, 4 and 6 per cent saffron-cardamom sugar syrup and 6, 8 and 10 per cent sugar. The most acceptable quality misti dahi can be prepared by using 8 per cent sugar and 6 per cent saffron-cardamom syrup.

Ratiba et al. (2006) [44] studied effect of cardamom, thyme and clove powder on the composition and quality of white soft cheese made from goat's milk. Cardamom, thyme and clove powder (0.10 and 0.20 per cent) were added to the cheese curd after whey drainage. The cheese were stored in brine at 6±1ºC and analyzed for chemical composition, microbiological quality and sensory properties when fresh and after 15, 30, and 45 days of storage. Cheeses with added cardamom developed less acidity than cheeses from other treatments. Addition of the tested spices decreased the total viable count and yeast and moulds with no effect on psychrophillic counts in cheese compared to control. Sensory evaluation showed that the addition of cardamom, thyme and clove improved the flavor and quality of white soft cheese made from goats' milk. From the studied found that cardamom and clove was used as a natural preservative in goat's cheese with improved flavor when stored at 6±1ºC for 45 days. Kapoor et al. (2009) [45] studied essential oil and oleoresins of cardamom as natural food preservatives for sweet orange (*Citrus sinensis*) juice. The essential oil and oleoresins (methanol, acetone, iso-octane and carbon tetrachloride) of large cardamom have been used as natural food preservatives for juice of sweet orange. Cardamom oil and oleoresin (acetone) were found best for increasing the shelf-life of juice. The addition of essential oil and various oleoresins of cardamom were effective in controlling the growth of spoilage microorganisms and, hence, act as natural food preservatives for sweet orange juice which increases the juice quality. Owing to these properties, cardamom oil and oleoresin can reduce the oxidative degradation of fatty substances. Moreover, cardamom is nontoxic and safe for public health, so it can be an acceptable alternative to chemical preservatives.

Bhatt and Verma (2016) [46] studied on development of herbal food product- bael (*aegle marmelos*) fruit toffee with objective to prepare toffee by incorporation of various herbs like cardamom and cinnamon. The 0.5% of cardamom and 1.0% of cinnamon were achieved highest score of sensory evaluation. A good *ragi* malt beverage was prepared using sugar powder with encapsulated cardamom mixed with malted *ragi* (finger millet) flour. This can be used in culinary sweets, flavoring of milk and milk products. Cardamom-flavored milk chocolate is prepared by using cocoa mass with butter, sugar powder, milk powder, encapsulated cardamom flavor and emulsifiers. The resultant product has good acceptability [47].

Uses Other than Dairy and Food Industry

Cardamom tincture is made by the extraction of crushed cardamom seeds along with other spices like caraway and cinnamon, and cochineal using 60 per cent alcohol as solvent. Glycerine is added at 5 per cent level to the extract and is used as a caraminative. Cardamom oil is also used in cosmetics because of its cooling properties and it is a pale to colorless liquid that can be easily incorporated into different solutions. The taste is warm and spicy and can be used as a flavor to chewing gum [33]. The essential oil can be blended with vegetable oils such as coconut oil to develop essential lotions and creams for healthy skin cell functioning. Due to its powerful cleansing, purifying, and insect repellent activities, cardamom essential oil can be mixed with lemon essential oil to develop natural wood preservative and polish. The essential oil, which is mostly employed for flavoring purposes in processed foods, can also be used in some liquid products including beverages and fruit drinks, alcoholic preparations, and liquors. Currently, the perfume and cosmetic industry uses essential oils as well as fruit extracts from several herbs and plants including cardamom to blend with other volatile and vegetable oils and develop naturally flavored cosmetic products and perfumes. Cardamom essential oil and oleoresins are also used as a soluble spice in the processed food industry for flavoring purposes [48,49].

ADULTERATION ISSUES

Decorticated seeds can be adulterated with seeds from lower grades, and also with seeds of large cardamom, as they are of similar shape, size and color. Small pebbles, orange seeds, unroasted coffee seeds and powdered cardamom hulls in cardamom seed powder will be added [50]. Examination of the surface of the seeds with a hand lens shows distinct differences, while the seed coat surface of true cardamom has clear furrows and ridges; the large cardamom has an almost smooth surface. Cereal and pulse flours and extracted ginger have been reported as adulterants. These can be detected using microscopy by the very different size and structure of the starch granules. Cardamom starch grains, unlike those of cereal and other starches, are very small (2–4 μ). Whole cardamom powder can be distinguished from the cardamom seed powder by microscopy. Cardamom seeds are often adulterated with seeds of *Amomum aromaticum* or *A. subulatum* and *A. cardamomum* (Wealth of India, 1952), and the fruits with orange seeds, unroasted coffee seeds as well as small pebbles. A thin layer chromatography (TLC) method has been developed that distinguishes and differentiates between true cardamoms (*Elettoria cardamomum* Maton) and large cardamoms (*Amomum subulatum Roxb*.). Extracted volatile oils are chromatographed on silica gel G with a n-hexane-diethylether (80+20) solvent system and visualized with a saturated solution of antimony trichloride in chloroform. The chromatographic pattern permits the detection of adulteration of one by another at levels as low as 5%. Camphor which is present in *Amomum cardamomum* but not in *Elettaria cardamomum* can be used as index to detect the admixture. Similarly *Amomum aromaticum Roxb*. can be distinguished from true cardamoms by its physicochemical properties, particularly its negative optical density and solubility behavior in alcohol. *Amomum aromaticum Roxb*. yields an oil which is clearly soluble in one volume of 80% alcohol. Powdered seeds are adulterated with the powder of hulls [51].

CONCLUSION

Cardamom is known as 'Queen of Spices'. The aroma and flavor of cardamom are obtained from the essential oils. Cardamom contains terpinene, sabinene, limonene, 1,8-cineole, fatty acids, sugar, starch, proteins etc. The whole, decorticated seeds, and fully grounded into powder forms of cardamom are used as flavoring agent in dairy and food industry. Cardamom is used in preparation of sweets, milk and milk products (like khoa, gulabjamun, sandesh, basundi, etc.), bakery products, cakes, bread, flavored pickles, rice and meat preparations, alcoholic and nonalcoholic beverages, frozen desserts, candies, puddings, condiments, relishes, gravies, etc. In addition to these, it is also used in cosmetics, lotions, ointments for healthy skin cell functioning, insect repellent, perfumes etc. Cardamom has excellent medicinal properties such as antiseptic,

carminative, digestive, diuretic, stimulant, stomachic, tonic and antispasmodic, antimicrobial and anti-inflammatory activities. Though cardamom has both flavoring as well as antimicrobial properties, there are only few reports available in literature on these aspects mainly focusing on sensory properties of food products incorporated with cardamom.

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