Chelonian Conservation And Biology

Vol. 18 No. 2 (2023) | https://www.acgpublishing.com/ | ISSN - 1071-8443

DOI: doi.org/10.18011/2023.11(2).640.658

A CRITICAL REVIEW OF THE NUTRITIONAL AND PHARMACOLOGICAL PROPERTIES OF *ELETTARIA CARDAMOMUM* (L.)

Sowmya K M[1], R T Narendhirakannan[1]*

[1]Department of Biochemistry, Kongunadu Arts & Science College (Autonomous), G.N. Mills P.O, Coimbatore, Tamil Nadu-641029, India.

***Corresponding Author**

Dr. R T Narendhirakannan

Assistant Professor, Department of Biochemistry, Kongunadu Arts and Science College (Autonomous), G.N. Mills P.O,Coimbatore, Tamil Nadu-641029, India.

Email: **rtnaren@kongunaducollege.ac.in**

ABSTRACT

For thousands of years, natural plant products have been the cornerstone of medicinal medicines due to their distinct pharmacological activities and structural variety. For millennia, people have employed natural plant products like spices as food flavorings and preservatives. Furthermore, from ancient times, spices have been utilized in medicine due to their known and assumed health benefits. Spices are essential for everyday health maintenance during a period of recurrent pandemics because they balance the "humors" in diet. The significance of selecting a spice now arises. "Elettaria cardamomum" is a well-known spice that has been used for flavoring numerous food preparations since ancient times. It is also known as Elaichi or cardamom. In addition to its strong therapeutic qualities, it has long been utilized as a folk cure for renal and digestive problems, lung and pulmonary tuberculosis, teeth and gum infections, and other ailments. This review offers data from the literature and evidence about the phytochemical components, bioactive substances, therapy of different ailments, and pharmacological effects of Elettaria cardamomum. Numerous investigations have demonstrated the biological activity of E. cardamomum and its polyphenols, which include metabolic regulation, antioxidant, anti-tumor, and anti-inflammatory properties.Elemimelon has abundant amounts of bioactive components, including limonene, α-terpinyl acetates, and 1,8-cineole and its esters. The current understanding of E. cardamomum's possible pharmacological effects and its usage in the pharmaceutical sector to develop innovative medications to treat a range of illnesses are the main topics of this review.

KEYWORDS: *Elettaria cardamomum*, natural products, nutraceuticals, pharmacological effect, therapeutic.

INTRODUCTION

Plants have always been an important source of natural remedies for humans. They contain a wide range of physiologically active compounds that are helpful in the fight against numerous diseases, including diabetes, cancer, atherosclerosis, and organic acids, among others. These include polyphenols, vitamins, terpenes, and organic acids. Natural components used in traditional folk medicine have thus served as the foundation for a number of therapeutic drugs with intriguing biological and pharmacological properties (**Dias *et al.,* 2012**). About 80% of the world's population relies on botanical preparations as medications to address their health needs, according to recent data from multiple researches (**Ekor, 2014**). Natural products continue to provide a unique structural variation in comparison to conventional combinatorial chemistry, which gives opportunities for identifying largely new low molecular weight lead compounds (**Cragg *et al.,* 2005**). Plant-based herbs and spices are generally considered safe and have been demonstrated to be effective against a variety of ailments (**Hema *et al.,* 2009**). Spices are any dried plant parts apart from leaves that are used to flavor and season meals without taking center stage.

For around 60% of the world's population, the safe administration of herbs and spices serves as the main form of medical treatment. One of the most important spices is Elettaria cardamomum (Elaichi), sometimes known as the "Queen of Spices". Elettaria cardamomum Maton, a member of the Zingiberaceae family, yields the seeds used to make cardamom spice (Morsy, 2015). The two main types of E. cardamomum are black Elettaria cardamomum from Amomum subulatum and green Elettaria cardamomum from Elettaria cardamomum (**Korikanthimathm VS *et al.,* 2014 & Choudhary S *et al.,* 2021**). Grown mostly in southern India, Tanzania, Guatemala, and Sri Lanka, it is a perennial herb native to the Indian subcontinent. Elettaria cardamomum is an evergreen shrub that reaches a maximum height of 2.6 meters. It grows in thick clusters of about 20 leafy stems. It also yields spindle-shaped fruits with a thin papery outer shell and small black seeds inside. Known as green or genuine Elettaria cardamomum, it yields fragrant, segmented pods or capsules containing 15–20 seeds (**Krishnan *et al.,* 2005; Reyes *et al.,* 2006**). *Elettaria cardamomum,* known for its unique fresh flavor and several medicinal properties, is one of the world's most costly and rare spices. Elettaria cardamomum is available in four different forms: oil, oleoresin, powder, and cardamom seeds (**Purseglove *et al.,* 1981**).

Worldwide, E. cardamomum is mostly utilized in medicine and within the country. Ever since the 4th century BC, bronchitis, asthma, constipation, colds, coughs, diuretic, carminative, tooth and gum infections, urinary and kidney disorders, lung congestion, pulmonary tuberculosis, irritation of the eyelids, cataracts, nausea, diarrhoea, and cardiac disorders have all been treated with E. cardamomum by ancient Greek and Roman physicians as well as Indian practitioners of Ayurveda (**Ashokkumar *et al.,* 2019**). It is commonly recognized that the oils and extracts from spices are utilized as nutraceuticals because they include a hydroxyl group in their phenolic

compounds, which makes them a good source of natural antioxidants, and also to flavor food (**Milda *et al.,* 2015**). In that sequence, E. cardamomum is rich in Vitamin C, Thiamine, Riboflavin, Niacin, Vitamin B6, Zinc, Copper, Iron, Sodium, Manganese, Potassium, Calcium, Magnesium, and Phosphorus (**Feng *et al.,* 2015**). The nutritional value of *E. cardamomum* is shown in Table 1. This review summarizes the nutritional and pharmacological uses of *Elettaria cardamomum.*

PHYTOCHEMICAL COMPOUNDS OF *ELETTARIA CARDAMOMUM*

Elettaria cardamom, often known as the "Queen of Spices", includes minerals, proteins, cellulose, pentosans, sugars, starches, silica, calcium oxalate, and steam-volatile oil. (**Senthil *et al.,* 2011**). Major metabolites such as alpha-pinene (1.5%), beta-pinene (0.2%), sabinene (2.8%), myrcene (1.6%), alpha phellandrene (0.2%), limonene (11.6%), 1,8, cineole (36.3%), terpinene (0.7%), cymene (0.1%), terpinolene (0.5%), linalool (3%) and other components with various biological applications such as antioxidant, anticancer, anti-inflammatory, anti-bacterial, anti-fungal, anti-proliferative, anti-diabetic, and anti-viral activities (**Sarkar *et al.,* 2011**). Additionally, other reports stated that the primary constituents of *Elettaria cardamomum* include flavonoids, alkaloids, terpenoids, anthocyanins, and other phenolic compounds, which were utilised to cure ailments related to stress, the respiratory, digestive, liver, renal, and other systems (**Vaidya *et al.,* 2014**).

According to the information now available, secondary metabolites from *Elettaria cardamomum* have been identified, and of them, 1,8-cineole is the most significant active substance, having demonstrated anticancer, cardiovascular, and anti-inflammatory activities (**Juergens *et al.,* 2014**). Previous studies also reported that a-Pinene has gastroprotective activity (**Polo *et al.,* 2012**) and sabinene and linalool have anti-inflammatory activities (**Valente *et al.,* 2013**). Biochemical substances from *Elettaria cardamomum* have been shown in numerous in vivo and in vitro tests to be effective in treating a variety of diseases. Table 2 lists the *Elettaria cardamomum's* chemical components (**Parthasarathy *et al.,* 2012**). The phytochemical screening carried out with methanol extract of *Elettaria cardamom* disclosed the presence of flavonoids, glycosides, and terpenoids (Bano *et al.,* 2016).

BIOLOGICAL EFFECTS OF *ELETTARIA CARDAMOMUM*

Elettaria cardamom oil, seed, and leaf extract have numerous medical uses, as shown in Table 3 below. This information was gathered from a number of internet scientific databases. (Science Direct, Elsevier, Web of Science, PubMed, Springer, Google Scholar, and textbook).

ANTIOXIDANT ACTIVITY

Antioxidants are compounds, either natural or artificial, that stop oxidation, which creates free radicals and other chain reactions that can damage an organism's cells. Many of the antioxidants that are utilized often now are naturally found in Elettaria cardamomum. The leaves, pods, and seeds of Elettaria cardamomum are among its numerous antioxidant-rich parts. These parts work to prevent free radical oxidative stress, which is the root cause of many degenerative disorders, such as diabetes, cancer, immune system issues, and Parkinson's disease (**Haliwell,**

2000). The 1,8-cineole, alpha terpineol, protocatechualdehyde, and protocatechuic acid extracted from seeds have antioxidant properties against lipid peroxidation (**Kikuzaki *et al.,* 2001**) and have many potential health benefits (**Jessie and Krishnakantha, 2005**). These or other seed-derived active ingredients have been linked to antioxidant activity in hepatic and cardiac antioxidant enzymes (**Verma *et al.,* 2010**).

Elettaria cardamom has strong antioxidant capability against oxidative stress and aids in scavenging free radicals, slowing down the aging of cells (**Amma *et al,* 2015 & Abu-Taweel, 2018**). According to several in vitro investigations, the polyphenol and other chemical components in the ethanolic extract of *A. subulatum* leaves make it a promising antioxidant (**Khare Divya *et al.,* 2012**). *Elettaria cardamomum* supplements with antioxidant activity have a potential effect on improving memory, neurotransmitter levels, and other behavioural attitudes. The antioxidant activity of *Elettaria cardamom* plays a critical function in the involvement of terpenoids and phenol (**Kapoor *et al.,* 2008**). Hence, it can be used as an alternative to manufactured antioxidants and the antioxidant potential of essential oil may be of great interest to the food and pharmaceutical industries (**Sudipta Jena *et al.,* 2021**). Potential free radical scavengers include significant chemicals like camphene, pinene, and caryophyllene oxide. (**Miri 2018; Tiwari *et al.,* 2009; Di Giacomo *et al.,* 2018; Porres-Martínez *et al.,* 2016**).

Essential oils of (*Amomum subulatum*) are thought to have high concentrations of phenolic chemicals that have considerable effects in antioxidant tests (**Singh *et al.,* 2008**). In addition to reducing cytokines including COX-2, IL-6, and TNF-α, treatment of hexane extract of *Elettaria repens* in rats at doses of 50 and 100 mg/kg also prevented carrageenan-induced paw edema and reduced the i-NOS-mediated NO production.

Elettaria cardamomum also demonstrated antioxidant properties by boosting the levels of SOD, catalase, and GSH and preventing lipid peroxidation in rats exposed to carrageenan. Overall, the findings imply that *Elettaria cardamom* may help reduce oxidative stress and inflammation (**Kandikattu *et al.,* 2017**). The polyphenols present in the spice extract have been found to have potent reducing and inhibitory properties against lipid peroxidation in the rat liver homogenate. Eventually, those polyphenols will function as substances that scavenge superoxide radicals (**Yadav and Bhatnagar, 2007**).

ANTIMICROBIAL ACTIVITY

The use of natural antimicrobials draws attention to a number of disease control issues. A few benefits include lowering antibiotic resistance among microbial pathogens, improving human immune cells, preventing microbial contamination of food, developing technologies to extend shelf life by eliminating undesirable microbes and/or delaying microbial spoilage, and reducing the demand for antibiotics. Elettaria cardamom contains a wide range of secondary metabolites, such as flavonoids, alkaloids, and tannins, some of which are believed to have antibacterial properties (**Ashokkumar *et al.,* 2021**). The crude extract of *Elettaria cardamom* effectively inhibited the growth of Enteropathogenic *E. coli* (Zone of inhibition = 20.3 mm) followed by normal *E.coli* (19mm). The crude extract also showed moderate bactericidal activity against *Listeria monocytogenes* and *Bacillus pumilus* (**Bano *et al.,* 2016**). The silver nanoparticles

synthesized using *Elettaria cardamom* seeds have anti-bacterial activity against *Bacillus subtilis* (Omprakash and Sharada, 2015).

The terpenoid constituents of *Elettaria cardamomum* are responsible for antifungal and antibacterial effects (**Hirasa and Takemasa 1998**). *Elettaria cardamom* may have broad-spectrum antibacterial and antifungal properties that could be utilized to stop the harm caused by infections that cause food poisoning and organisms that cause food to rot (**Ahmed *et al.,* 2019**). The researchers hypothesised that the bactericidal properties of *Elettaria cardamomum* essential oil may be related to its capacity to harm some bacteria's cell membranes. Additionally, the results of the study showed that *Elettaria cardamom* was efficient *against Candida albinos, Salmonella typhi, Escherichia coli, Streptococci mutans*, and *Staphylococcus aureus* (**Abdullah *et al.,* 2017**). This activity is likely related to the presence of high amounts of 1, 8-cineol (**Souissi *et al.,* 2020**). The role of essential oil (from seeds) against various keratinophilic and dermophytic fungi is not limited but they are believed to have a much broader antifungal spectrum as discussed by (**Singh *et al.,* 2008**). Therefore, it is important to investigate and carry out research in the future about the "broad-spectrum fungal inhibition" property of chemicals found in big *Elettaria cardamomum* essential oils.

Diethyl ether was used to make an extract from *Elettaria cardamomum* seeds that have a potent inhibitory effect on several infections. It might be helpful to add *Elettaria cardamom* to food as an antibacterial ingredient (**Ağaoğlu *et al.,* 2006**). According to the zone of inhibition data from the current investigation, *Elettaria cardamomum* seeds, leaves, and crude oil had powerful antibacterial activity against various human pathogenic Gram-positive and Gram-negative bacteria. This activity was seen against *Salmonella typhi* and this outcome is comparable to (**Arora *et al.,* 2007**). Additionally, *Salmonella typhi* was sensitive to *Elettaria cardamom* essential oil at high concentrations, which demonstrated considerably stronger activity (**Singh *et al.,* 2009**). *Elettaria cardamomum* may play a crucial role in the development of ostensibly safe and innovative antibiotics to counteract currently used conventional antibiotics.

ANTI-INFLAMMATORY ACTIVITY

Compounds that may help combat inflammation are abundant in the *Elettaria cardamom*. *Elettaria repens* has a high polyphenol, flavonoid, and terpene content in its hexane extract. Extracts of *Elettaria cardamomum* reduce the inflammatory response in macrophages that have been exposed to LPS. *Elettaria cardamomum's* anti-inflammatory actions were accompanied by increased interleukin expression. Because of their potent antibacterial and anti-inflammatory qualities, *Elettaria cardamomum* extracts may be used therapeutically to treat periodontal infections, according to a study that offered experimental support (**Souissi *et al.,* 2020**). *Elettaria cardamom* and its polyphenols revealed its significant molecular effects by controlling the detoxification and antioxidant enzymes through the activation of the Nrf2 transcription factor. Such research may also help to reduce NF-κB, the main transcription factor that regulates inflammation. Recent clinical investigations utilizing cardamom as a nutraceutical along with rosemary extract had high concentrations of 1,8-cineole and exhibited that these substances had anti-inflammatory effects in patients with COVID-19 and might eliminate the cytokine storm.

Moreover, early administration of these extracts to CoVID-positive patients showed that the inflammatory markers IL10, IL-6, and TNF-alfa were reduced dramatically. (**Nourin Shakib *et al.,* 2022**). The promotion of *Elettaria cardamomum* or its extract for the treatment of various inflammatory and metabolic illnesses is based on all these diverse effects. The anti-inflammatory actions of *Elettaria cardamomum* are greatly aided by activating Nrf2, which also reduces the inflammatory response mediated by NF-κB. (**Li W *et al.,* 2008**). A study indicated *Elettaria cardamomum* aqueous extracts have increased interleukin expression, indicating they may have anti-inflammatory or immunomodulatory properties.

The aqueous and acetone extract of *Elettaria cardamomum* seeds demonstrated a higher percentage of reduction of paw inflammation such as 31% and 30% respectively, which were compared to the reference medication ibuprofen (23%) (**Shantaram Arpitha *et al.,* 2019**). According to a study by Nithya (2018), the anti-inflammatory properties of *Elettaria cardamomum* oil may be attributed to a decrease in TNF- α, IL1, and IL6, which may limit COX-2 expression and its byproduct PGE2. Green *Elettaria cardamomum* components were discovered to have considerable antioxidant and anti-inflammatory effects when compared to ibuprofen and regular ascorbic acid, respectively. The molecular docking investigation demonstrated the significant affinity for human-peroxiredoxin-5, tyrosine kinases, and human-5-LOX receptors of terpinyl acetate and 1,8-cineole. The in-silico prediction study verified the antioxidant and anti-inflammatory capabilities, whilst the pharmacokinetics confirmed the safety of most of the green *Elettaria cardamomum* components (**Aftab Alam *et al.,* 2021).** The study done by **Gustavo R *et al.,* (2021)** showed that the *Elettaria cardamomum* aqueous extract has anti-inflammatory properties but no cytotoxic effects on the peritoneal cell line HeLa, J774A.1, Vero E6, and Balb/C. Finally, it was discovered that the extracts also reduced peritoneal macrophages' nitric oxide (NO) production.

ANTI-CANCER ACTIVITY

Natural compounds found in *Elettaria cardamom* may be able to fight conditions like cancer. The ability to inhibit several oxidation pathways was found to have the most important role in anticancer efficacy. The *Elettaria cardamomum* extracts contained bioactive substances such flavonoids and triterpenoids, which contributed to the anti-oncogenic properties. Limonene, cineole, linalool, pinene, and borneol are phytochemicals from *Elettaria cardamomum* that have been proven to be protective against the advancement of cancer. The oral administration of aqueous suspension of *Elettaria cardamomum* (100µl) to male Swiss albino mice for 15 days caused their skin tumours to become smaller and lighter (**Samir Qiblawi *et al.,* 2012**). Through in vitro research, the essential oil of *Elettaria cardamomum* proved its anti-carcinogenic properties by preventing aflatoxin B1 from damaging adult DNA in a reaction mediated by microsomal enzyme 13 (**Hashim *et al.,* 1994**). The aqueous extract of *Elettaria cardamomum* exhibited cytotoxicity against HeLa, J774A.1, and Vero E6 cell lines with the EC_{50} values of 424.01 µg/mL, EC50 237.36 µg/mL, EC50 257.51 µg/mL respectively. Furthermore, the study also found that increasing the concentration of extract enhanced the inhibitory effects (**Cárdenas Garza GR *et al.,* 2021**).

Elettaria cardamom's anti-inflammatory, antiproliferative, and pro-apoptotic properties have also been shown to reduce azoxymethane-induced colon carcinogenesis. Aqueous *Elettaria cardamomum* solutions can increase the activity of the detoxifying enzyme GST and reduce lipid peroxidation (**Bhattacharjee, *et al.,* 2007**). Also mentioned was the fact that the phytochemical components such as limonene and 1, 8-cineole present in the essential oil of *Elettaria cardamomum* have been shown to have a preventative effect against the development of cancer, inhibit the activities of cyclooxygenase-2 and cytochrome P450, and cause the down-regulation of numerous signal transduction molecules (**Neeta *et al.,* 2016**). According to certain research, consuming *Elettaria cardamomum* oil alters the xenobiotic metabolism-related enzymes, which may help to prevent cancer (**Banerjee *et al.,* 1994**). Swiss Albino mice were used to evaluate *Elettaria cardamomum* colonic aberrant crypt foci (ACF) behaviour caused by azoxymethane (AOM). *Elettaria cardamomum* also modifies the expression of inducible nitric oxide synthase (iNOS) and COX-2, which are necessary for the development of apoptosis. The findings reported the preventive effects of *Elettaria cardamomum* on experimentally generated colon carcinogenesis (**Sengupta *et al.,* 2005**).

The highest suppression of Michigan Cancer Foundation (MCF-7) cells—an Estrogen Receptor (ER)-positive cell line was achieved at a concentration of 500 g/mg of black cardamom seed oil. Indole-3-carbinol (IC3) and diindolylmethane (DIM), two phytochemicals found in *Elettaria cardamom*, stimulated the growth of certain white blood cells, including natural killer cells, and inhibit hormone receptor-positive breast cancer cells. The *Elettaria cardamom* (20 mg/ml) proved its chemo-preventive action against the tested cell lines such as HEP-G2 and MCF (**Vutakuri, N and Somara, S 2018).** *Elettaria cardamomum* is a powerful anti-myeloma medication that has the capacity to limit the viability and proliferation of Multiple Myeloma cells (**Zhihua Z *et al.,* 2014**). Oral administration of *Elettaria cardamomum* essential oil for 26 weeks at doses of 100 and 200 mg/kg/day significantly decreased serum lactate dehydrogenase (LDH) activity, urea, and creatinine levels in rats subjected to diethylnitrosamine (DENA)-induced oxidative stress (**Elguindy *et al.,* 2018**). One of *Elettaria cardamomum's* bioactive components, D-limonene, has been shown to have chemopreventive effects on mice's skin, stomach, colon, liver, breast, and lung malignancies (**Asamoto M *et al.,* 2002**).

Human leukaemia cells are exposed to limonene, which causes apoptosis by suppressing the production of Bcl-2 and mutant p53 (**Guo XM *et al.,* 2006**). In vitro, cineole causes morphological alterations and apoptotic bodies to form in human leukemia cells (**Moteki H *et al.,* 2002**). Natural killer cells' cytotoxic activity is markedly increased by *Elettaria cardamomum* extracts, indicating a potential anti-cancer effect. A study done by **Raksamiharja *et al.,* (2012**) reported that in doxorubicin-treated rats, *Elettaria cardamomum* oil dramatically enhanced the number of lymphocytes, CD4 +, and CD8 + in a dose-dependent manner. According to another study, the active ingredient in *Elettaria cardamom*, eugenol, dramatically increases the in vitro proliferation of lymphocytes (**Block RM *et al.,* 1978**). Experimental data and phytochemical composition indicate that *Elettaria cardamom* may have health benefits against a variety of cancers (**Qiblawi *et al.,*2020**).

Elettaria cardamomum-mediated gold nanoparticles exhibited significant cytotoxicity effects by decreasing the viability of Hela cell lines with increasing concentrations ranging from 6.25 to 100 µL **(Rajan *et al.,* 2017).** The silver nanoparticles (AgNPs) synthesized with *Elettaria cardamomum* (seed) extract were discovered to have dose-dependent cytotoxicity against Human Larynx Carcinoma carcinoma (Hep-2) with the inhibitory concentration (IC_{50}) of 51g/ml **(Krishnan *et al.,* 2015).**

ANTI-ULCEROGENIC ACTIVITY

The *Elettaria cardamom* plant may be useful for stomach problems. Some people mix spice with tea to relieve stomach discomfort. Additionally, it might help prevent stomach ulcers. The following investigations revealed *Elettaria cardamomum* and its primary aroma ingredient, 1,8 cineole possess gastroprotective properties. Rats' susceptibility to aspirin and ethanol-induced stomach ulcers was examined using methanolic extract, essential oil, petroleum ether soluble, and insoluble fractions of methanol extract of *Elettaria cardamomum*. (**Jamal *et al.,* 2006**). *Elettaria cardamomum's* alcoholic solution became blue-green when combined with ferric chloride, showing the presence of phenolic chemicals. The presence of phenolic chemicals in this fraction, such as flavanones, aurones, or anthocyanins, may be responsible for significant gastroprotective effects. (**Lakshmi and Chauhan, 1977)**

Interestingly, 1,8-cineole, a phytoconstituent of *Elettaria cardamomum* demonstrated the gastro-protective impact by considerably reducing the ethanol-induced mucosal damage in rats (**Santo *et al.,* 2001).** The *Elettaria cardamomum* essential oil proved its gastroprotective effects via the reduction in stomach motility and an inhibitory effect on the overproduction of certain 5-lipoxygenase pathway products (**Jamal, *et al.,* 2005**). The findings of yet another study confirmed the potential benefit of 1,8-cineole as a food flavour in preventing gastrointestinal ulcers. Following trinitrobenzene sulfonic acid (TNBS) colitis in rats, animals pretreated with 1,8-cineole showed a significant decrease in the gross damage scores and wet weights of colonic segments (**Bruzzo *et al.,* 2007**). *Elettaria cardamom's* free radical scavenging, antioxidant, and anti-inflammatory properties have been demonstrated to have contributed to the gastroprotective effect that has been seen.

ANTI-DIABETIC ACTIVITY

Elaichi, also known as *Elettaria cardamomum*, is a wonderful spice that may be able to regulate your blood sugar levels. A study showed that the ethanolic *Elettaria cardamomum* leaf extract could restore body weight in alloxan-induced diabetic rats and lower blood glucose and total cholesterol levels. *Elettaria cardamom* is incredibly high in manganese, which can reduce the chance of developing diabetes (**Winarsi *et al.,* 2014**). According to a recent study (**Ahmed *et al.,* 2017**), supplementing with *Elettaria cardamom* has anti-diabetic benefits and may control glucose metabolism by inhibiting the enzymes -amylase and -glucosidase. According to the study, when rats were fed a diet high in fat and carbohydrates, those who also received *Elettaria cardamom* powder had lower weights and healthier cholesterol levels than the rats who did not receive this supplement (**Rahman *et al.,* 2017**). In a different trial, 83 patients with type 2 diabetes were given either green *Elettaria cardamom* or a placebo. After 10 weeks, those who took *Elettaria cardamom*

exhibited health advantages, such as reduced insulin and haemoglobin A1c (**Aghasi M *et al.,* 2019**).

According to the study, there aren't many randomised clinical trials examining the effects of green *Elettaria cardamom* supplementation on blood pressure, glycemic indices, and serum lipids in overweight and obese pre-diabetic women. The findings demonstrated that an eight-week *Elettaria cardamomum* intake had no effect on blood pressure and blood biomarkers when compared to a placebo. But in the *Elettaria cardamomum* group, TC and LDL-C dramatically dropped, and insulin sensitivity rose. Furthermore, mean HDL-C levels were kept constant in the *Elettaria cardamomum* group (**Fatemeh, Y *et al.,* 2017**)

EFFECTS ON ORAL HEALTH

Elettaria cardamom's antimicrobial properties enhance dental health. The powerful flavor of Elettaria cardamom even encourages salivation, which may help lower the incidence of dental cavities. Elettaria cardamom is also a useful remedy for bad breath. It has been demonstrated that gum flavored with Elettaria cardamom is helpful in lessening the symptoms of nicotine withdrawal in smokers attempting to quit (**Cohen *et al.,* 2010**) *Elettaria cardamomum* extracts are efficient against oral pathogenic bacteria like *Streptococcus mutans* and *Candida albicans*, according to a recent study on the antimicrobial properties of *Elettaria cardamomu*m extracts on oral bacteria (**Aneja *et al.,* 2009**).

EFFECTS ON THE LIVER HEALTH

Elettaria cardamom has astringent properties. Though scientific evidence to back this claim is lacking, Elettaria cardamomum does appear to have some beneficial effects on the liver, which is an important organ involved in the removal of toxins from the body. In one study, non-alcoholic fatty liver disease was seen in people who were obese or overweight. The participants who took green Elettaria cardamom supplements saw improvements in their indexes of liver health (**Daneshi-Maskooni *et al.,* 2018**). Rats were given a diet heavy in fat and carbohydrates while certain liver health markers were being watched. Within eight weeks, rats given Elettaria cardamomum showed reduced liver stress compared to rats on an unsupplemented diet. According to this study, Elettaria cardamom might help shield the liver from some forms of harm **(Rahman *et al.,* 2017).**

EFFECTS ON THE DIGESTION

Its exceptional digestive qualities are attributed to Elettaria cardamomum essential oil. This oil facilitates better digestion by stimulating the entire digestive tract. Furthermore, it preserves the health and proper function of the stomach due to its stomachic nature. It aids in the stomach's normal production of bile, acids, and gastric juices. It also protects the stomach from infections (**Jesylne *et al.,* 2016**).

EFFECTS ON THE SKIN AND HAIR

Elettaria cardamom, or black pepper, flushes out toxins that could damage skin. Chewing black Elettaria cardamomum helps the body get detoxified, leading to cleaner skin. Elettaria cardamom, particularly the black kind, offers health-promoting antioxidant properties that nourish

and improve the condition of the scalp. Additionally, the spice nourishes and fortifies hair follicles (**Jazila *et al.,* 2007**).

APHRODISIAC

Elettaria cardamom is a power aphrodisiac. Elettaria cardamom oil has a stimulating effect that aids in the treatment of erectile dysfunction, frigidity, impotence, and poor sexuality. Elettaria cardamomum powder has a high cineole content, which can release nerve stimulants and arouse your desires with just a modest teaspoon of the spice. Certain research suggest that Elettaria cardamom can be utilized to treat impotence as well (**Rajathi *et al.,* 2017**).

CONCLUSION AND PERSPECTIVES

Spices have a rich history as well as a fascinating array of unusual flavors, colors, and scents that initially made them so valuable. Owing to their antimicrobial properties, spices have also been used as preservatives and in traditional medicine. They are commonly referred to as aromatic plant components, including bark, seeds, roots, pods, and leaves, which enhance the hedonic response in addition to offering diversity in the human diet. The "Queen of Spice," Elettaria cardamomum, is investigated in this investigation for both its unique scent and its numerous medicinal uses. Numerous historical applications of Elettaria cardamomum have been validated by contemporary in vitro and in vivo pharmacological studies. The current review provides information on the biological components of Elettaria cardamomum that have anti-inflammatory, anti-cancerous, anti-oxidant, and other therapeutic actions. Additionally, Elettaria cardamomum-synthesised nanoparticles have a wide range of therapeutic applications. Therefore, the risk of acquiring lifestyle diseases can be decreased if Elettaria cardamomum is introduced to food consumption. This is as a result of the presence of all these biological components in Elettaria cardamomum. Since Elettaria cardamomum has a long history and has shown to be reliable, it's important to find out if the plant is the subject of any ongoing pharmacological research that may be used to assess its traditional use. Numerous clinical studies have proven the pharmacological effect of Elettaria cardamomum; shortly, this fundamental research should translate into commercial development, paving the way for Elettaria cardamomum to become a preferred nutraceutical in a range of medical circumstances.

Kingdom	• Plantae
Sub-kingdom	• Tracheobionta
Super-division	• Spermatophyta
Plant division	• Magnoliophyta
Plant Class	• Liliopsida
Sub class	• Lingberries
Order	• Zingiberales
Family	• Zingiberaceae
Genus	• Elettaria Maton
Species	• *Elettaria cardamomum* (L.)

Fig 1: Taxonomic classification of *Elettaria cardamomum* (L.)

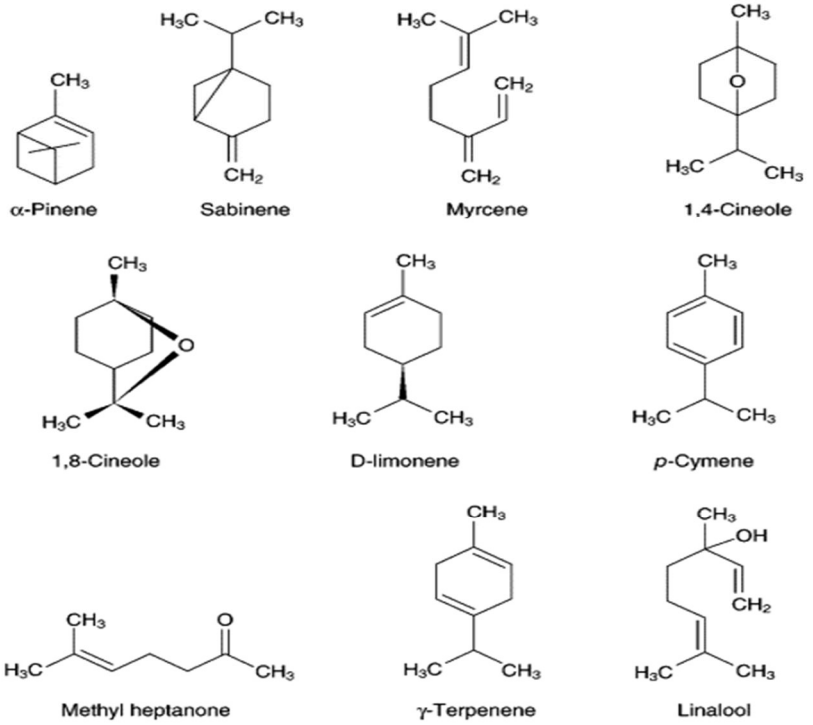
Table 1: Cardamom, Nutritional value per 100 g

Nutrient	Value
Energy	311 Kcal
Carbohydrates	68.47 g
Protein	10.76 g
Total Fat	6.7 g
Cholesterol	0 mg
Dietary Fiber	28 g
Vitamins	
Niacin	1.102 mg
Pyridoxine	0.230 mg
Riboflavin	0.182 mg
Thiamin	0.198 mg
Vitamin A	0 IU
Vitamin C	21 mg
Electrolytes	
Sodium	18 mg
Potassium	1119 mg
Minerals	
Calcium	383 mg
Copper	0.383 mg
Iron	13.97 mg
Magnesium	229 mg
Manganese	28 mg
Phosphorus	178 mg
Zinc	7.47 mg

(Composition of Foods: Spices and Herbs. USDA Agriculture Handbook8-2, January 1977,

The Nutritional Composition of Spices, ASTA Research Committee, February 1977)

Table 2:-Chemical Constituents of Cardamom



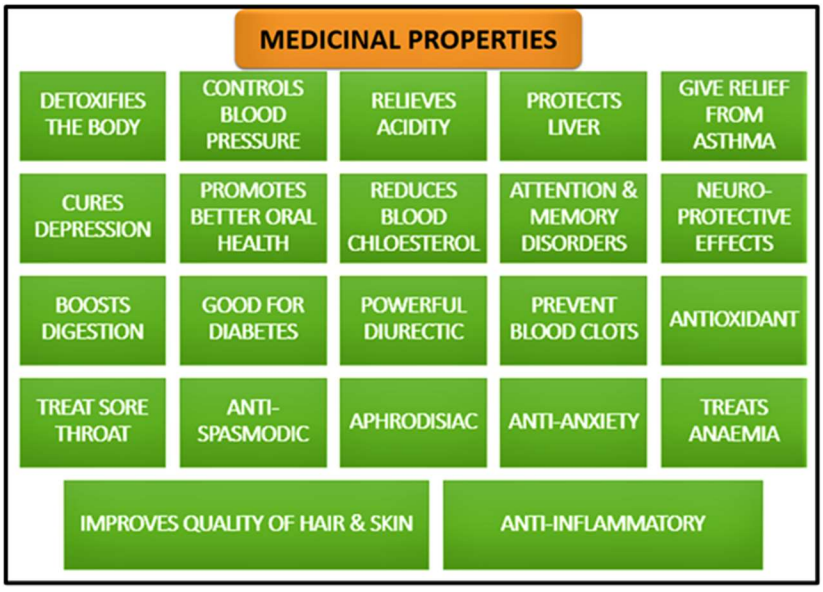


Fig 2: Medicinal properties of Cardamom

REFERENCE

1. Abdullah, Asghar, A., Butt, M.S. et al. Evaluating the antimicrobial potential of green cardamom essential oil focusing on quorum sensing inhibition of Chromobacterium violaceum. J Food Sci Technol 54, 2306–2315,2017. https://doi.org/10.1007/s13197-017-2668-7
2. Abu-Taweel GM. Cardamom (*Elettaria cardamomum*) perinatal exposure effects on the development, behavior and biochemical parameters in mice offspring. Saudi J Biol Sci. 25(1):186–193,2018. https://doi.org/10.1016/j.sjbs.2017.08.012.
3. Aftab Alam, Talha jawaid & Pravej Alam. In vitro antioxidant and anti-inflammatory activities of green cardamom essential oil and in silico molecular docking of its major bioactives, Journal of Taibah University for Science,15:1,757768,2021, doi: 10.1080/16583655.2021.2002550
4. Ağaoğlu, Sema, Nursel Dostbil, and Süleyman Alemdar. "Antimicrobial effect of seed extract of cardamom (*Elettarıa cardamomum* Maton)." YÜ Vet Fak Derg 16.2: 99-101,2006.
5. Aghasi, M., Koohdani, F., Qorbani, M., Nasli-Esfahani, E., Ghazi-Zahedi, S., Khoshamal, H., Keshavarz, A. and Sotoudeh, G. Beneficial effects of green cardamom on serum SIRT1, glycemic indices and triglyceride levels in patients with type 2 diabetes mellitus: a randomized double-blind placebo controlled clinical trial. J. Sci. Food Agric., 99: 3933-3940,2019. https://doi.org/10.1002/jsfa.9617.
6. Ahmed AS, Ahmed Q, Saxena AK, and Jamal P. Evaluation of in vitro antidiabetic and antioxidant characterizations of *Elettaria cardamomum* (L.) Maton (Zingiberaceae), *Piper cubeba* L. f. (Piperaceae), and *Plumeria rubra* L. (Apocynaceae). Pak. J. Pharm. Sci; 30(1) ,113–126.2017.
7. Ahmed, Hamza & Ramadhani, Ashraf & Erwa, Ibrahim. Phytochemical Screening, Chemical Composition and Antibacterial Activity of Essential Oil of Cardamom. World Journal of Pharmaceutical Research. 8. 1166-1175, 2019.
8. Aneja, K. R., and Radhika Joshi. "Antimicrobial activity of Amomum subulatum and *Elettaria cardamomum* against dental caries causing microorganisms." Ethnobotanical Leaflets 2009.7: 3,2009.
9. Arora, D. S., & Kaur, G. J. Antibacterial activity of some Indian medicinal plants. Journal of natural medicines, 61(3), 313-317,2007.
10. Asamoto M, Ota T, Toriyama-Baba H, Hokaiwado N, Naito A, Tsuda H. Mammary carcinomas induced in human c-Ha-ras proto-oncogene transgenic rats are estrogen-independent, but responsive to d-limonene treatment. Jpn J Cancer Res.93(1):32-5. 2002 Jan, doi: 10.1111/j.1349-7006. 2002.tb011972002.
11. Ashokkumar, K., Murugan, M., Dhanya, M. K., & Warkentin, T. D. Botany, traditional uses, phytochemistry and biological activities of cardamom [*Elettaria cardamomum* (L.) Maton]–A critical review. Journal of ethnopharmacology, 246,112244,2019.

12. Ashokkumar, Kaliyaperumal & Murugan, Muthusamy & Dhanya, M.K. Cardamom [*Elettaria Cardamomum* (L.) Maton]: Production, Breeding, Management, Phytochemistry and Health Benefits, 2021.
13. Banerjee S, Sharma R, Kale RK, Rao AR. Influence of certain essential oils on carcinogen-metabolizing enzymes and acid-soluble sulfhydryls in mouse liver. Nutr Cancer ;21(3):263-9,1994, doi: 10.1080/01635589409514324.
14. Bano S, Ahmad N, Sharma AK. Phytochemical screening and evaluation of anti-microbial and anti-oxidant activity of *Elettaria cardamomum* (Cardamom). Journal of Applied and Natural Science. 2016 Dec 1;8(4):1966-70. https://doi.org/10.31018/jans.v8i4.1071
15. Bhattacharjee S, Rana T, Sengupta A. Inhibition of lipid peroxidation and enhancement of GST activity by cardamom and cinnamon during chemically induced colon carcinogenesis in Swiss albino mice. Asian Pac J Cancer Prev.8:578–82, 2007.
16. Block RM, Lewis RD, Sheats JB, Fawley J. Cell-mediated immune response to dog pulp tissue altered by eugenol within the root canal. Oral Surg Oral Med Oral Pathol;45(3):452-463,1978.
17. Bruzzo J, Chiarella P, Fernandez G, Bustuoabad OD, Ruggiero RA. Systemic inflammation and experimental cancer in a murine model. Medicina (B Aires), 67(5):469-474, 2007.
18. Cárdenas Garza GR, Elizondo Luévano JH, Bazaldúa Rodríguez AF, et al. Benefits of Cardamom (*Elettaria cardamomum* (L.) Maton) and Turmeric (Curcuma longa L.) Extracts for Their Applications as Natural Anti-Inflammatory Adjuvants. Plants (Basel). 2021;10(9):1908. Published 2021 Sep 14. doi:10.3390/plants10091908.
19. Choudhary S, Madhusudan S, Bhawana W, Chaudhary G, Black Cardamom (Amomum Subualtum): A Review. International Journal of Current Research Vol. 13, Issue, 04, pp.17027-17032, April, 2021 DOI: https://doi.org/10.24941/ijcr.40962.04.2021
20. Cohen LM, Collins FL Jr, Vanderveen JW, Weaver CC. The effect of chewing gum flavor on the negative affect associated with tobacco abstinence among dependent cigarette smokers. Addict Behav; 35:955-60, 2010.
21. Cragg G.M., Newman D.J. Biodiversity: A continuing source of novel drug leads. Pure Appl.Chem.77: 7–24, 2005.
22. Daneshi-Maskooni, M., Keshavarz, S.A., Qorbani, M. et al. green cardamom increases Sirtuin-1 and reduces inflammation in overweight or obese patients with non-alcoholic fatty liver disease: a double-blind randomized placebo-controlled clinical trial. Nutr Metab (Lond) 15, 63, 2018. https://doi.org/10.1186/s12986-018-0297-4.
23. Di Giacomo, S., Abete, L., Cocchiola, R., Mazzanti, G., Eufemi, M. and Di Sotto, A. Caryophyllane sesquiterpenes inhibit DNA-damage by tobacco smoke in bacterial and mammalian cells. Food Chem. Toxicol. 111: 393-404.34, 2018.
24. Dias, D. A., Urban, S., & Roessner, U. A historical overview of natural products in drug discovery. Metabolites, 2(2), 303–336, 2012. https://doi.org/10.3390/metabo2020303.

25. Ekor M. The growing use of herbal medicines: issues relating to adverse reactions and challenges in monitoring safety. Front Pharmacol. 2014 Jan 10; 4:177. doi: 10.3389/fphar.2013.00177.
26. Elguindy NM, Yacout GA, El Azab EF. Amelioration of DENA-induced oxidative stress in rat kidney and brain by the essential oil of *Elettaria cardamomum*um. Beni-Suef University Journal of Basic and Applied Sciences.7(3):299-305, 2018.
27. Fatemeh, Y., Siassi, F., Rahimi, A. et al. The effect of cardamom supplementation on serum lipids, glycemic indices and blood pressure in overweight and obese pre-diabetic women: a randomized controlled trial. J Diabetes Metab Disord 16, 40, 2017.doi.org/10.1186/s40200-017-0320-8.
28. Feng, K & Rababah, H & Tashtoush, T & datt, S & Torley, G & And, P & Ereifej, Khalil & Feng, Hao & Rababah, Taha & Tashtoush, Sufyan & Aludatt, Muhammad & Al-Rabadi, Ghaid & Torley, Peter & Alkasrawi, Malek. Microbiological Status and Nutritional Composition of Spices Used in Food Preparation. Food and Nutrition Sciences. 6. 1134-1140,2015, https://doi.org/10.4236/fns.2015.612118.
29. Guo XM, Lu Q, Liu ZJ, Wang LF, Feng BA. [Effects of D-limonene on leukemia cells HL-60 and K562 in vitro]. Zhongguo Shi Yan Xue Ye Xue Za Zhi.14(4):692-695, 2006.
30. Gustavo R. Cárdenas Garza, et al. "Benefits of Cardamom (*elettaria Cardamomum* (l.) Maton) and Turmeric (curcuma Longa L.) Extracts for Their Applications as Natural Anti-inflammatory Adjuvants." Plants, v. 10,.9 -. 2021 doi: 10.3390/plants10091908
31. Halliwell, B. The antioxidant paradox. Lancet. 355, 1179-1180, 2000.
32. Hashim, S., Aboobaker, V.S., Madhubala, R., Bhattacharya, R.K., Rao, A.R., Modulatory effects of essential oils from spices on the formation of DNA adduct by aflatoxin B1 in vitro. Nutr. Cancer 21, 169–175, 1994.
33. Hema R, Kumaravel S and Elanchezhiyan N. Antimicrobial Activity of Some of the South Indian Spices and Herbals against Food Pathogens. Journal of Pharmacology. 3(1): 38-40, 2009.
34. Hirasa, K., & Takemasa, M. Spice Science and Technology (1st ed.). CRC Press. 1998, https://doi.org/10.1201/9780367800451.
35. Jamal A, Javed K, Aslam M, Jafri MA. Gastroprotective effect of cardamom, *Elettaria cardamomum* Maton. fruits in rats. J Ethnopharmacol.103(2):149-153, 2006.
36. Jamal, A., Siddiqui, A., Aslam, M., Javed, K., & Jafri, M. A. Antiulcerogenic activity of *Elettaria cardamomum* Maton. and Amomum subulatum Roxb. Seeds, 2005.
37. Jazila, E.M., Mount Assif, D. and Amarouch, H. Antimicrobial activity of *Elettaria cardamomum*: Toxicity, biochemical and histological studies. International Journal of Drug Formulation and Research, Food Chemistry; 104, 2007.

38. Jessie SW and Krishnakantha TP. Inhibition of human platelet aggregation and membrane lipid peroxidation by food spice, saffron. Mol Cell Biochem, 278: 59-63, 2005.doi: 10.1007/s11010-005-5155-9
39. Jesylne P, Soundarajan S, Murthykumar K, et al. The Role of Cardamom Oil in Oral Health: A Short Review. Res J Pharm Technol; 9(3): 272p,2016.
40. Juergens UR. Anti-inflammatory properties of the monoterpene 1.8-cineole: current evidence for co-medication in inflammatory airway diseases. Drug Res. 64(12):638–646, 2014.
41. K. P. Padmakumari Amma, Indu Sasidharan, M. M. Sreekumar, M. A. Sumathykutty & C. Arumughan.Total Antioxidant Capacity and Change in Phytochemicals of Four Major Varieties of Cardamom Oils During Decortication, International Journal of Food Properties, 18:6, 1317-1325, 2015, doi: 10.1080/10942912.2011.587621.
42. Kandikattu HK, Rachitha P, Jayashree GV, Krupashree K, Sukhith M, Majid A, Amruta N, Khanum F. Anti-inflammatory and anti-oxidant effects of Cardamom (Elettaria repens (Sonn.) Baill) and its phytochemical analysis by 4D GCXGC TOF-MS. Biomed Pharmacother; 91:191-201, July 2017, doi: 10.1016/j.biopha.2017.04.049.
43. Kapoor IPS, Singh B, Singh G, Isidorov V, Szczepaniak L. Chemistry, antifungal and antioxidant activities of cardamom (Amomum subulatum) essential oil and oleoresins. Int J Essent Oil Ther; 2: 29–40, 2008.
44. Khare, Divya & Kumar, Brajesh & Hussain, Arshad & Verma, Shikhar & Mishra, Mala. Evaluation of antioxidant activity of large cardamom (leaves of Amomum subulatum). International Journal of Drug Development and Research. 4. 175-179,2012.
45. Kikuzaki H, Kawai Y and Nakatani N. Diphenyl-2- picrylhydrazyl radical-scavenging active compounds from greater cardamom (Amomum subulatum Roxb.). J Nutr Sci Vitaminol, 47(2): 167-171, 2001, doi: 10.3177/jnsv.47.167.
46. Korikanthimathm VS, Prasath D, Rao G. Medicinal properties of cardamom *Elettaria cardamomum*um. Journal of Medicinal and Aromatic Crops. 683-685, 2014.
47. Krishnan V, Kalyanaraman R, Fathima G, Sheriff K, Illiyas M, Rather HA, Thangam R, Krishnan T. Green biosynthesis of silver nanoparticles from *Elettaria cardamomum*um (Seed) and it's in vitro cytotoxic activity. cancer cells. 2015 Jan 17; 9:10.
48. Krishnan S, Bhosale R, Singhal RS. Microencapsulation of cardamom oleoresin: Evaluation of blends of gum arabic, maltodextrin and a modified starch as wall materials. Carbohydr Polym; 61:95-102, 2005.
49. Lakshmi, V., Chauhan, J.S. Structure of a new Aurone gly-coside from Amomum subulatum seeds. Indian Journal of Chemistry 15B, 814–815, 1977.
50. Li W, Khor TO, Xu C, Shen G, Jeong WS, Yu S, Kong AN. Activation of Nrf2-antioxidant signaling attenuates NFkappaB-inflammatory response and elicits apoptosis. Biochem Pharmacol;76(11):1485-1489, 2008.

51. Milda E. Embuscado, Spices and herbs: Natural sources of antioxidants – a mini review, Journal of Functional Foods, Volume 18, Part B, Pages 811-819, ISSN 1756-4646, 2015, https://doi.org/10.1016/j.jff.2015.03.005.
52. Miri, S. Phytochemistry, Antioxidant, and Lipid Peroxidation Inhibition of the Essential Oils of Lavandula Officinalis L. in Iran. Int. J. Food Prop. 21: 2550-255, 2018.
53. Morsy NFS. A short extraction time of high quality hydrodistilled cardamom (*Elettaria cardamomum* L. Maton) essential oil using ultrasound as a pretreatment. Ind Crop Prod; 65: 287–292p, 2015.
54. Moteki H, Hibasami H, Yamada Y, Katsuzaki H, Imai K, Komiya T. Specific induction of apoptosis by 1,8-cineole in two human leukemia cell lines, but not a in human stomach cancer cell line. Oncol Rep;9(4):757-760, 2002.
55. Neeta, B, Archana C. Spices as an Alternative Therapy for Cancer treatment. Systematic reviews in Pharmacy;26(1):46-56, 2016.
56. Nithya, S. "Anti-inflammatory effect of *Elettaria cardamomum* oil on carrageenan-induced paw edema using rats based on tumor necrosis factor α, interleukin 6, and interleukin 1 levels in serum." Asian J. Pharm. Clin. Res 11: 207,2018.
57. Omprakash V, Sharada S. Green synthesis and characterization of silver nanoparticles and evaluation of their antibacterial activity using *Elettaria cardamomum* seeds. J. Nanomed. Nanotechnol. 2015 Mar 1; 6:2-5. DOI: 10.4172/2157-7439.1000266
58. Polo CM, Moraes TM, Pellizzon CH, Marques MO, Rocha LR, Hiruma-Lima CA. 2012. Gastric ulcers in middle-aged rats: The healing effect of essential oil from Citrus aurantium L. (Rutaceae). Evid Based Complement Alternat Med:509451,2012.
59. Porres-Martínez, M., González-Burgos, E., Carretero, M.E. and Gómez-Serranillos, M.P, M.P. In vitro neuroprotective potential of the monoterpenes á-pinene and 1, 8-cineoleagainst H2O2-induced oxidative stress in PC12 cells. Z. Naturforsch. C. 71: 191-199.32, 2016.
60. Purseglove, J. W., Brown, E. G., Green, C. L., & Robbins, S. R. J. Spices Vol. 2 (pp. 447-813). Longman Group Ltd 1981.
61. Qiblawi, Samir & Kausar, Adnan & Shahid, Shaneela & Saeed, Mohd & Alazzeh, Awfa. (2020). Therapeutic Interventions of Cardamom in Cancer and Other Human Diseases. Journal of Pharmaceutical Research International. 32. 74-78, 2020. 10.9734/JPRI/2020/v32i2230774.
62. Rahman, M. M., Alam, M. N., Ulla, A., Sumi, F. A., Subhan, N., Khan, T., Sikder, B., Hossain, H., Reza, H. M., & Alam, M. A. Cardamom powder supplementation prevents obesity, improves glucose intolerance, inflammation and oxidative stress in liver of high carbohydrate high fat diet induced obese rats. Lipids in health and disease, 16(1), 151, 2017, doi.org/10.1186/s12944-017-0539-x.
63. Rajan A, Rajan AR, Philip D. *Elettaria cardamomum*um seed mediated rapid synthesis of gold nanoparticles and its biological activities. OpenNano. 2017 Jan 1; 2:1-8. https://doi.org/10.1016/j.onano.2016.11.002

64. Rajathi A, Angeline & Antony, Allwyn & Leslie, Shilu & M.M, Pragalyaashree. Processing and Medicinal Uses of Cardamom and Ginger-A Review. Journal of Pharmaceutical Sciences and Research. 9. 2117 -2122 ,2017.
65. Raksamiharja R, Sy K, Novarina A, Sasmito E. *Elettaria cardamomum* distillate increases cellular immunity in doxorubicin treated rats. Indonesian Journal of Cancer Chemoprevention;3(3):437-443.39, 2012.
66. Reyes T, Luukkanen O, Quiroz R. Small cardamom - precious for people, harmful for mountain forests: possibilities for sustainable cultivation in the East Usambaras, Tanzania. Mt Res Dev; 26:131-7, 2006.
67. Samir Qiblawi, Awdah Al-Hazimi, Mohammed Al-Mogbel, Ashfaque Hossain, and Debasis Bagchi Chemopreventive Effects of Cardamom (*Elettaria cardamomum* L.) on Chemically Induced Skin Carcinogenesis in Swiss Albino Mice Journal of Medicinal Food 15:6, 576-580, 2012.
68. Santos FA, Rao VS. 1,8-cineol, a Food Flavoring Agent, Prevents Ethanol-Induced Gastric Injury in Rats. Dig. Dis.Sci.46(2):331-337, 2001.
69. Sarkar P.R. V Ed. AMPS Publication, Purulia; West Bengal: 2011. Yaogic Treatment and Natural Remedies; p. 105. [Google Scholar]
70. Sengupta A, Ghosh S, Bhattacharjee S. Dietary cardamom inhibits the formation of azoxymethane-induced aberrant crypt foci in mice and reduces COX-2 and iNOS expression in the colon. *Asian Pac J Cancer Prev*; 6:118–122, 2005.
71. Senthil, Amudha & BHAT, K.K. Best estimated taste detection threshold for cardamom (*Elettaria cardamomum* maton) aroma in different media. Journal of Sensory Studies, 2011.
72. Shakeeb N, Varkey P, Hynse A, Mandlecha A. Anti-inflammatory response of cardamom extract and prediction of therapeutic window in COVID-19 patients by assessing inflammatory markers using RT-PCR. Inflammopharmacology.30(3):883-894,2022. doi:10.1007/s10787-022-00951.
73. Shantaram Arpitha, Krishnapura Srinivasan, and Halagur B. Sowbhagya. Anti-inflammatory effect of resin fraction of cardamom in carrageenan-induced rat paw edema. PharmaNutrition- volume 10, pages-100165; issn 2213-4344, 2019, doi.org/10.1016/j.phanu.2019.100165.
74. Singh G, Kapoor IPS, Singh B, Isidorov V and Szczepaniak L. Chemistry, antifungal and antioxidant activities of cardamom (Amomum subulatum) essential oil and oleoresins. Int J Essential Oil Ther, 2: 29-40, 2008.
75. Singh G, Kiran S, Marimuthu P, Isidorov V and Vinogorova V. (Antioxidant and antimicrobial activities of essential oil and various oleoresins of *Elettaria Cardamomum* (seeds and various oleoresins of *Elettaria Cardamomum* (seeds and pods)). JSciFood Agric; 88:280-289, 2009.
76. Souissi M, Azelmat J, Chaieb K, Grenier D. Antibacterial and anti-inflammatory activities of cardamom (*Elettaria cardamomum*) extracts: Potential therapeutic benefits for

periodontal infections. Anaerobe; 61: 102089, 2020 https://doi.org/10.1016/j.anaerobe.2019.102089.

77. Sudipta Jena, Asit Ray, Ambika Sahoo, Bibhuti Bhusan Champati, Bhuban Mohan Padhiari, Biswabhusan Dash, Sanghamitra Nayak & Pratap Chandra Panda: Chemical Composition and Antioxidant Activities of Essential oil from Leaf and Stem of *Elettaria cardamomum* from Eastern India, Journal of Essential Oil-Bearing Plants, 2021, doi:10.1080/0972060X.2021.1937335.
78. Tiwari, M. and Kakkar, P. Plant derived antioxidants–geraniol and camphene protectrat alveolar macrophages against t-BHP induced oxidative stress. Toxicol. In Vitro. 23: 295-301.33, 2009.
79. V.A. Parthasarathy, D. Prasath, 8 – Cardamom. In Woodhead Publishing Series in Food Science, Technology and Nutrition, Handbook of Herbs and Spices (Second Edition), Woodhead Publishing, Pages 131-170, 2012.
80. Vaidya A., Rathod M. An in vitro study of the immunomodulatory effects of Piper nigrum (black pepper) and *Elettaria cardamomum* (cardamom) extracts using a murine macrophage cell line. Am. Int. J. Res. Formal, Appl. Nat. Sci;8(1):18–27, 2014.
81. Valente J, Zuzarte M, Gonc¸alves MJ, Lopes MC, Cavaleiro C, Salgueiro L, Cruz MT. Antifungal, antioxidant and anti-inflammatory activities of Oenanthe crocata L. essential oil. Food Chem Toxicol. 62:349–354, 2013.
82. Verma SK, Rajeevan V, Bordia A and Jain V. Greater cardamom (Amomum subulatum Roxb.) – A cardioadaptogen against physical stress. J Herb Med Toxicol, 4(2): 55-58, 2010.
83. Vutakuri, N., & Somara, S. Natural and herbal medicine for breast cancer using *Elettaria cardamomum*um (L.) Maton. Int J Herbal Med, 6(2), 91-96,2018.
84. Winarsi, H., Sasongko, N.D., Purwanto, A., & Nuraeni, I. Effect of cardamom leaves extract as antidiabetic, weight lost and hypocholesterolemic to alloxan-induced Sprague dawley diabetic rats. international food research journal, 21, 2253-2261, 2014.
85. Yadav AS and Bhatnagar D. Modulatory effect of spice extracts on iron-induced lipid peroxidation in rat liver. Biofactors, 29: 147- 157, 2007. doi: 10.1002/biof.552029205.
86. Zhihua Z, Jianping Y, Miaomiao S, Kuisheng C. Exploration for the multi-effect of cardamom in's resistance to multiple myeloma. Pak J Pharm Sci;27(6 Suppl):2001-6, 2014.