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Green Tea an Antioxidant

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INTRODUCTION:

Green tea (*Camellia sinensis*, *Theaceae*) is the most widely consumed beverage, following water [1]. Polyphenols in green tea are thought to be responsible for the cancer preventive effects observed in laboratory and epidemiological studies. Daily intake of polyphenols from green tea is high in some countries. Roughly 34 % of the total polyphenol consumption from beverages in Japan comes from green tea [02]. The green tea phenolic compounds of highest concentration are gallic acid (GA), (–)-gallocatechin (GC), (+)-catechin (C), (–)-epicatechin (EC), (–)-epigallocatechin (EGC), (–)-epicatechin gallate (ECG), (–)-epigallocatechin gallate (EGCG), *p*-coumaroylquinic acid (CA), and (–)-gallocatechin-3-gallate (GCG) (Fig 1), with EGCG being the most abundant by weight [03][4] Green tea also contains condensed and hydrolyzable tannins [05]. Green tea has the highest concentration of polyphenols compared to other teas, including EGCG, which may be why green tea can induce apoptotic cell death in cancer better than other teas [06]. Green tea is used as a hot or cold beverage. It is an evergreen shrub that can be grow up to the heights of 30 feet but is usually pruned to 2- 5 feet for cultivation.

Fig 1: cultivation.

Botanical Classification of Green Tea:

Table 1

Kingdom	Plantae – Plants
Subkingdom	Tracheobionta – Vascular plants
Superdivision	Spermatophyta – Seed plants
Division	Magnoliophyta – Flowering plants
Class	Magnoliopsida – Dicotyledons
Subclass	Dilleniidae
Order	Theales
Family	Theaceae – Tea family
Genus	Camellia L. – camellia
Species	Camellia sinensis (L.) Kuntze - tea

Green Tea Processing: Unfermented green tea is a widely consumed beverage worldwide.

- Green tea is acknowledged as a herbal remedy
- The aroma and flavour of green tea are more significant.
- Green tea has a chlorophyll level of 1.2 to 1.5 mg/g of tea leaves.
- With a vast network of tea producers, retailers, wholesalers, auctioneers, exporters, and packers, the tea business is one of the first organised ones in India.
- Tea is globally one of the most popular and cheapest beverages with major production centres in India, China, Kenya, Sri Lanka, Turkey and Vietnam.

1. The global productivity during 1991 was 1026 kg/ha which climbed to mere 1100 kg/ha in 2000. In the first decade of the 21st century, global tea productivity hovered between 1100-1160kg/ha.

Fig2: Green Tea Processing

Uses :

1. **Contains healthy bioactive compounds :**

Green tea is more than just a hydrating beverage.

The green tea plant contains a range of healthy compounds that make it into the final drink (1Trusted Source).

Tea is rich in polyphenols, which are natural compounds that have health benefits, such as reducing inflammation and helping to fight cancer.[7]

Green tea contains a catechin called epigallocatechin-3-gallate (EGCG). Catechins are natural antioxidants that help prevent cell damage and provide other benefits.[13]

2. May improve brain function:

Green tea does more than just keep you alert, it may also help boost brain function

Research has consistently shown that caffeine can improve various aspects of brain function, including mood, vigilance, reaction time, and memory (6Trusted Source).[7]

However, caffeine isn't the only brain-boosting compound in green tea. It also contains amino acid L-theanine, which can cross the blood-brain barrier .L-theanine increases the activity of the inhibitory neurotransmitter GABA, which has anti-anxiety effects. It also increases dopamine and the production of alpha waves in the brain (7, 8Trusted Source, 9Trusted Source).[7]

Studies show that caffeine and L-theanine can have synergistic effects. This means that the combination of the two can have particularly powerful effects in improving brain function (10Trusted Source, 11Trusted Source).

Because of the L-theanine and the small dose of caffeine, green tea may give you a much milder and different kind of buzz than coffee.

3. Increases fat burning

If you look at the ingredients list for any fat burning supplement, chances are, green tea will be on there.

This is because, according to research, green tea can increase fat burning and boost metabolic rate .

In one study involving 10 healthy men, taking green tea extract increased the number of calories burned by 4%. In another involving 12 healthy men, green tea extract increased fat oxidation by 17%, compared with those taking a placebo (13Trusted Source, 14Trusted Source).[7]

However, some studies on green tea don't show any increase in metabolism, so the effects may depend on the individual and how the study was set up (15Trusted Source).

Two separate review studies reported that caffeine may increase physical performance by approximately 11–12% (18Trusted Source, 19Trusted Source).

4. Antioxidants may lower the risk of some cancers

Cancer is caused by uncontrolled growth of cells. It's one of the world's leading causes of death.

Research has shown that oxidative damage can lead to chronic inflammation, which can lead to chronic diseases, including cancers. Antioxidants can help protect against oxidative damage (20Trusted Source).

Green tea is an excellent source of powerful antioxidants.[7]

Research has linked green tea compounds with a reduced risk of cancer, including the following studies:

- **Breast cancer.** A comprehensive review of observational studies found that women who drank the most green tea had an approximately 20–30% lower risk of developing breast cancer, one of the most common cancers in women (21Trusted Source).
- **Prostate cancer.** One study observed that men drinking green tea had a lower risk of advanced prostate cancer
- **Colorectal cancer.** An analysis of 29 studies showed that those drinking green tea were around 42% less likely to develop colorectal cancer (23Trusted Source).[7]
- The cancer-protective effects of green tea have been reported in several population-based studies. For example, cancer rates tend to be low in countries such as Japan where green tea is regularly consumed. It is not possible to determine from these population-based studies whether green tea actually prevents cancer in people. However, emerging animal and clinical studies are beginning to suggest that EGCG may play an important role in the prevention of cancer. It has been suggested that EGCG and other tea catechins suppress tumour growth by inhibiting the release of tumour necrosis factor-alpha, which is believed Table I. Chemical composition of green tea leaves (http://www.bodyofmine.com). Constituent Percentage (% of dried leaf) Polyphenols 37.0 Carbohydrates 25.0 Caffeine 3.5 Protein 15.0 Aminoacids 4.0 Lignin 6.5 Organic acids 1.5 Lipids 2.0 Ash 5.0 Chlorophyll 0.5 234 V. R. Sinija & H. N. Mishra to stimulate tumour promotion and progression of initiated cells as well as pre-malignant cells[10]

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5. **May help prevent type 2 diabetes**

The rates of type 2 diabetes are increasing in recent decades. The condition now affects about 1 in 10 Americans .

Type 2 diabetes involves having elevated blood sugar levels, which may be caused by insulin resistance or an inability to produce insulin.

Studies show that green tea may improve insulin sensitivity and reduce blood sugar levels (42Trusted Source).

One study in Japanese individuals found that those who drank the most green tea had an approximately 42% lower risk of type 2 diabetes (43Trusted Source).

According to a review of 7 studies with a total of 286,701 individuals, tea drinkers had an 18% lower risk of diabetes (44Trusted Source).

6. **May help you live longer**

Given that some compounds in green tea may help protect against cancer and heart disease, it makes sense that it could help you live longer.

In one study, researchers studied 40,530 Japanese adults over 11 years. Those who drank the most green tea — 5 or more cups per day — were significantly less likely to die during the study period (56Trusted Source):

- **Death of all causes:** 23% lower in women, 12% lower in men
- **Death from heart disease:** 31% lower in women, 22% lower in men
- **Death from stroke:** 42% lower in women, 35% lower in men

Another study involving 14,001 older Japanese individuals found that those who drank the most green tea were 76% less likely to die during the 6-year study period).

Although the anti-cancer effects of EGCG may be attributed to a pro-oxidant effect, high oral doses of EGCG (750 – 1500 mg/kg) have been shown to exert hepatotoxic effects in CF-1 mice.

The hepatotoxic effects were associated with increased markers of oxidative stress such as lipid peroxidation, plasma 8-isoprostane, metallothionein, and γ-histone 2AX protein[21]

Health benefit:

The secret of green tea lies in the fact that it is rich in catechin, polyphenols, particularly EGCG. The EGCG is a powerful anti-oxidant: besides inhibiting the growth of cancer cells, it kills cancer cells without harming healthy tissue. It has also been effective in lowering LDL cholesterol levels, inhibiting the abnormal formation of blood clots, reduction of platelet aggregation, lipid regulation and inhibition of proliferation and migration of smooth muscle cells. Inhibition of abnormal blood clots formation takes on added importance when you consider that thrombosis (the formation of abnormal blood clots) is the leading cause of heart attacks and stroke. Any of these factors might be promising in reducing cardiovascular diseases. The major and most chemo-preventive constituent in green tea responsible for these biochemical or pharmacological effects is (-)-epigallocatechin-3-gallate. Understanding the molecular mechanisms of these effects of green tea is a subject of investigation in many laboratories [8]

1:

Today, scientific research in both Asia and the west is providing hard evidence for the health benefits long associated with drinking green tea. For example, in 1994 the Journal of the National Cancer Institute published the results of an epidemiological study indicating that drinking green tea reduced the risk of esophageal cancer in Chinese men and women by nearly 60%. University of Purdue researchers recently concluded that a compound in green tea inhibits the growth of cancer cells. There are also reports indicating that drinking green tea lowers total cholesterol levels, as well as improves the ratio of good cholesterol (HDL) to bad cholesterol (LDL). [9]

2:

The production of active metabolites by the components of green tea that undergo several metabolic processing like glucuronidation, methylation, and sulfation. Various studies resulted that after consumption of green tea there is a detection of catechins and their metabolites in blood plasma, urine and different tissues of the body. There are various parameters by which the measurement of ingested green tea extract has to be conducted bioavailability of blood plasma is studied after 2 hrs of ingestion and of urine is after 4-6hrs of ingestion. The metabolites like EC and EGC is to be detected in blood plasma and urine. From the last two decades, a number of researchers have been led to determine the health benefits attributed to consumption of green tea and its extracts. These research has shown that green tea has a variety of potential health benefits. These benefits include:[17]

Fig 3: uses

Literature Review:-

1) Yang CS,. 2009: et.al Extracts of tea, particularly tea, and tea polyphenols are shown to inhibit the formation and development of tumours at totally different organ sites in animal models. there's goodly proof that tea polyphenols, above all (−)-epigallocatechin-3-gallate, inhibit catalyst activities and signal transduction pathways, leading to the suppression of cell proliferation and improvement of necrobiosis, similarly because the inhibition of cell invasion, maturation and metastasis. Here, we have a tendency to review these biological activities and existing knowledge relating tea consumption to human cancer risk in an endeavor to grasp the potential use of tea for cancer interference.

2) Fukushima Y,.2009 et.al: Food and beverages made in polyphenols with inhibitor activity square measure highlighted as a possible issue for risk reduction of way connected diseases. This study was conducted to elucidate total polyphenol consumption from beverages in Japanese individuals. Total polyphenol (TP) contents in beverages were measured employing a changed Folin-Ciocalteu technique removing the interference of reduced sugars by mistreatment reverse-phase chromatography. A drinkable consumption survey was conducted within the national capital and Osaka areas in 2004. at random designated male and feminine subjects (10-59 years previous, n = 8768) recorded the amounts and kinds of all nonalcoholic beverages consumed in an exceedingly week. Concentration of TP in low, green tea, black tea, Oolong tea, barley tea, drinkable, tomato/vegetable juice, and cocoa drinks were at two hundred, 115, 96, 39, 9, 34, 69, and sixty two mg/100 cubic centimetre, severally. Total consumption of beverages in an exceedingly Japanese population was one.11 +/- 0.51 L/day, and TP contents from beverages was 853 +/- 512 mg/day. low and tea shared five hundredth and thirty fourth of TP consumption in beverages, severally, and contribution of every of the opposite beverages was but 100 percent. TP contents in twenty major vegetables and five fruits were 0-49 mg and 2-55 mg/100 g, severally. inhibitor activities, atomic number 29 reducing power, and scavenging activities for DPPH and superoxide, of these samples correlative to the TP contents ($p <$ zero.001).

   Beverages, particularly low, contributed to an oversized share of the consumption of polyphenols, as antioxidants, within the Japanese diet

3) 3 Baptista JAB. 1998;et.al :–tea leaf polyphenols (GTP) from bush (L.) O. Kuntze square measure the key water soluble elements in tea liquor. The GTP extraction yield determined victimization completely different extraction times from ten to sixty min at seventy degrees C, and additionally at completely different temperatures from fifty degrees C to one hundred degrees C, keeping the extraction time constant. The composition of the GTP (catechins) from samples of various origins determined by RP-HPLC, activity the absorbance at 280 nm. The standardisation curves of the catechins were linear between five weight unit and a couple of micrograms, and their C.V. values for the quantitation were but four.0% for four replicates victimization four completely different sets of every kind. the whole epicatechin derivatives (EPD) and epigallocatechin-3-gallate (EGCG) from Azorean tea leaf, accounted for seventy four.5 and 47.9% (w/w) of the whole GTP, severally, and were compared therewith from tea samples of various origins. The EGCG:caffeine magnitude relation in

Azorean tea leaf was fourfold higher as compared with others, that prompt an honest supply of a chemopreventive agent. The aroma composition of various tea leaf samples was compared victimization the SPME/GC indefinite quantity methodology.

4) Engelhardt UH,: 2004.et.al. : Increased public awareness of health benefits of green tea is generally based on the high polyphenol content of tea leaves and the resulting beverage. A number of factors, such as species, season, agronomic condition and age of the leaves, are known to affect the composition of commercial teas. In the present study the effects of factors associated with domestic preparation and analytical methods, such as brewing time, concentration, solvent and type of tea product, on levels of catechins and caffeine, antioxidant activity and estimated daily intakes were investigated. There were large variations in the levels of total catechins: 43 and 117mg g−1 dry matter (DM) (brewed for 30 s and 5 min respectively); 72 and 161 mg g−1 DM (extracted in boiling water and 50% acetonitrile respectively); 72 and 117mg g−1 DM (a tea bag and tea leaves respectively). The effects on caffeine content were comparatively smaller. These variations consequently led to considerable variations in estimated daily intakes based on three cups (600 ml), ranging between 538 and 2014 mg g−1 DM of total catechins and between 103 and 466mg g−1 DM of caffeine. The antioxidant activity was highest (26 680 μmol g−1 DM) for tea leaves brewed for 5 min and lowest (10 110 μmol g−1 DM) for a tea bag product brewed for 1 min. 2005 Society of Chemical Industry

5) Chow HHS, Hakim IA. 2007et.al.: Purpose: Green tea consumption has been associated with decreased risk of certain types of cancers in humans. Induction of detoxification enzymes has been suggested as one of the biochemical mechanisms responsible for the cancer-preventive effect of green tea. We conducted this clinical study to determine the effect of repeated green tea polyphenol administration on a major group of detoxification enzymes, glutathione S- transferases (GST).

Antioxidant:

The removal of ROS by antioxidant defense systems is essential for healthy periodontium. Antioxidants scavenge the free radicals. The balance is maintained between oxidants and antioxidants. Under pathologic conditions, a disturbance in favor of ROS production results in oxidative stress. Antioxidants may be regarded as "those substances which when present at low concentrations, compared to those of an oxidizable substrate, will significantly delay or inhibit oxidation of that substrate." Antioxidants function either by preventing oxidative stress by literally scavenging radicals as they form or by sequestering transition metal ions and preventing Fenton reactions or by catalyzing the oxidation of other molecules[11]

Activity of GST was elevated in humans after consuming 800 mg EGCG per day (in polyphenon E tablets) for 4 weeks. The effect, however, was only observed in subjects with low GST baseline activity. Activity of GST was actually decreased in subjects with high baseline activity[22]

This beneficial effect has been attributed to the presence of high amounts of polyphenols, which are potent antioxidants. In particular, green tea may lower blood pressure and thus reduce the risk of stroke and coronary heart disease. Some animal's studies suggested that green tea might protect against the development of coronary heart disease by reducing blood glucose levels and body weight [23] However, all these data are based on middle-aged animals' populations, not the elderly populations, which nutritional status tends to be more adversely influenced by age-related biological and socioeconomic factors [24]

Antioxidant Activity : we also found that the antioxidant capacity per serving of green tea (436 mg vitamin C equivalents) was much higher than that of black tea (239 mg).

Therefore, we conclude that green tea has more health benefits than an equal volume of black tea in terms of antioxidant capacity.[26] TF are low (2–6% of extracted solids) and thearubigens (>20%) are high in black tea, whereas in green tea, catechins are much higher (30–42%), particularly EGCG, which is the most abundant catechin. In addition, as discussed in our report[27]

POLYPHENOLS AS ANTIOXIDANTS :

Fermentation leaches out some of these beneficial ingredients. As green tea is made from unfermented leaves, it contains the highest concentration of powerful **antioxidants called polyphenols**. [13]

Antioxidants such as polyphenols in green tea can neutralize the free radicals and may reduce or even help prevent some of the damages they cause. The healthful properties of green tea are largely attributed to polyphenols, chemicals with potent antioxidant properties. The antioxidant effects of polyphenols appear to be greater than those of vitamin C. Polyphenols contained in teas are classified as catechins. Green tea contains six primary catechin compounds: catechin, gallaocatechin, epicatechin, epigallocatechin, epicatechin gallate (Ecg), and epigallocatechin gallate (also known as EGCg). EGCg is the most studied polyphenol component in green tea. The scavenging capacity of catechin and epicatechin molecules depends on their hydrogen donating ability. It is demonstrated that polyphenols have inhibitory effect on the ROS generation as well as on the release of lysosomal enzymes.

Green tea also contains alkaloids including caffeine, theobromine, and theophylline. These alkaloids provide green tea's stimulant effects. l-theanine, an amino acid compound found in green tea, has been studied for its calming effects on the nervous system. Green tea also contains carotenoids, tocopherols, ascorbic acid (vitamin C), minerals such as chromium, manganese, selenium or zinc, and certain phytochemical compounds. Most green tea dietary supplements are sold as dried leaf tea in capsule form. There are also liquid extracts made from the leaves and leaf buds. An average cup of green tea contains between 50 and 150 mg polyphenols (antioxidants)[14]

Direct antioxidant effects of green tea :

In vitro effects : Green tea polyphenols scavenge reactive oxygen species (ROS) by generating more stable phenolic radicals. The radical scavenging ability of EGCG has been a focus of many studies due to high relative concentrations in green tea and presence of the galloyl group on the B and D ring. Electron paramagnetic resonance (EPR) spectroscopy has revealed that EGCG reacts with O2– leading to oxidation of the D ring [19] PR has also shown that EGCG can scavenge OH and O2 20

Although the anti-cancer effects of EGCG may be attributed to a pro-oxidant effect, high oral doses of EGCG (750 – 1500 mg/kg) have been shown to exert hepatotoxic effects in CF-1 mice. The hepatotoxic effects were associated with increased markers of oxidative stress such as lipid peroxidation, plasma 8-isoprostane, metallothionein, and γ-histone 2AX protein[21]

Indirect antioxidant effects of green tea :

Green tea polyphenols can have indirect antioxidant effects *in vivo*. Intraperitoneal injections with green tea polyphenols, have been shown to increase levels of phase II antioxidant enzymes in rat livers including glutathione peroxidase and reductase, glutathione-S-transferase (GST), catalase, quinone reductase, and superoxide dismutase[12]

Mechanism of antioxidant activity :

[Halliwell B et al., 1994; Zhao B et al., 2001; Sang S et al., 2003; Kelly MR et al., 2001; Anderson RF et al., 2001] [16]

The greater part of the catechins has a wide cluster of organic activities relating especially to their compound structure. At present, huge numbers of the catechins' activities have been recognized, however, the systems behind these activities have not been completely illustrated. Their most popular and generally eminent natural activity is their cancer prevention agent and free radical rummaging properties. In any case, it is the developing proof of assorted activities on exchange cell pathways that has pulled in so much consideration as of late. Moreover, the catechins' glucuronide metabolite that structures B-ring O-methylated catechins has little cell reinforcement movement because of its decreased H-giving properties, however, can ensure against cytotoxicity as successfully as its parent compound.

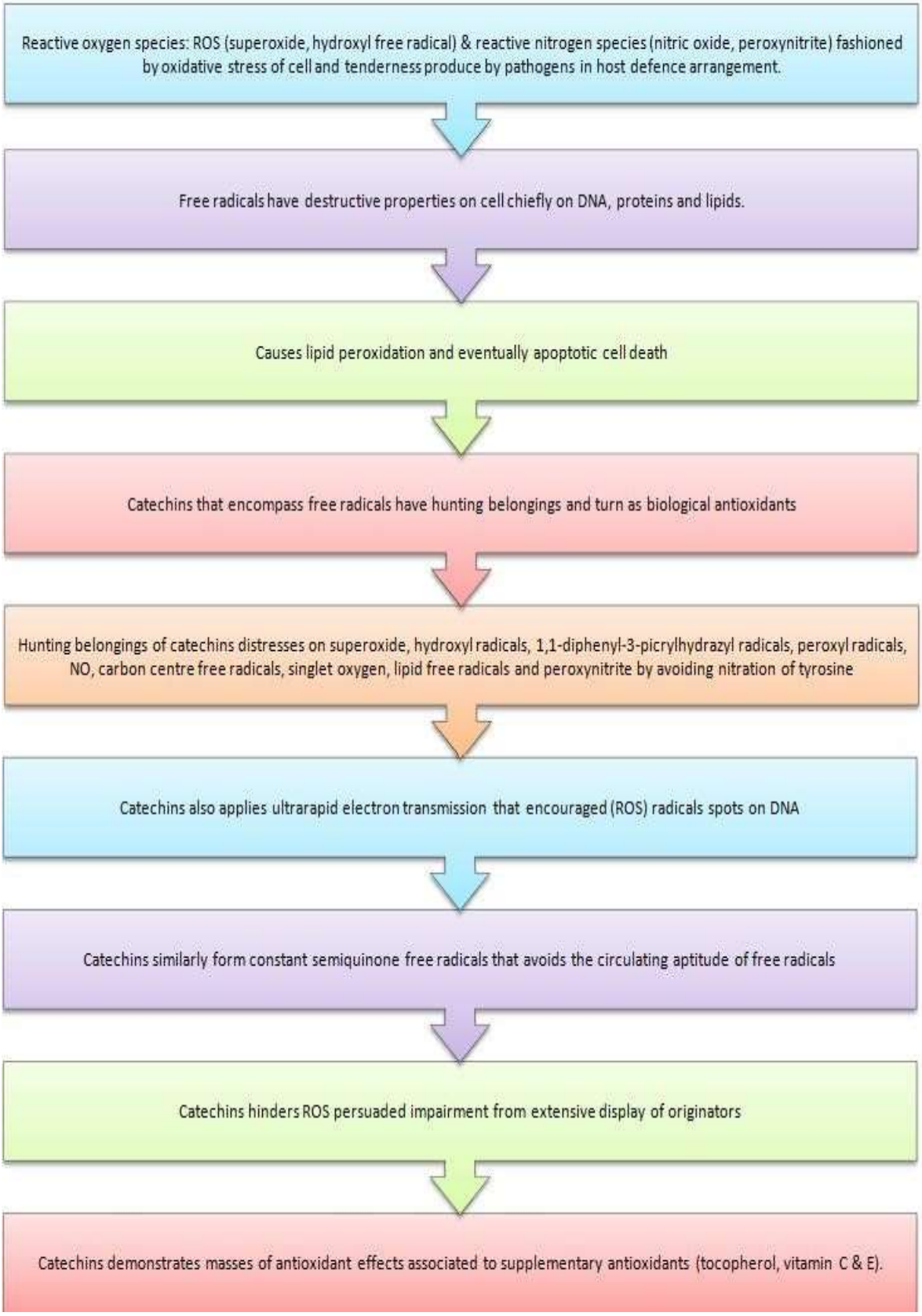

Fig:4 Mechanism of antioxidant

Composition of antioxidant compounds: -

[Kanwar et al., 2012; Balentine et al., 1997] To find out the antioxidant and anti-inflammatory properties of a compound characteristic property of structure helps such as the presence of a benzo-pyran structure having at leastone aromatic ring shows the presence of antioxidant and anti-inflammatory properties of the respective compound. [17]

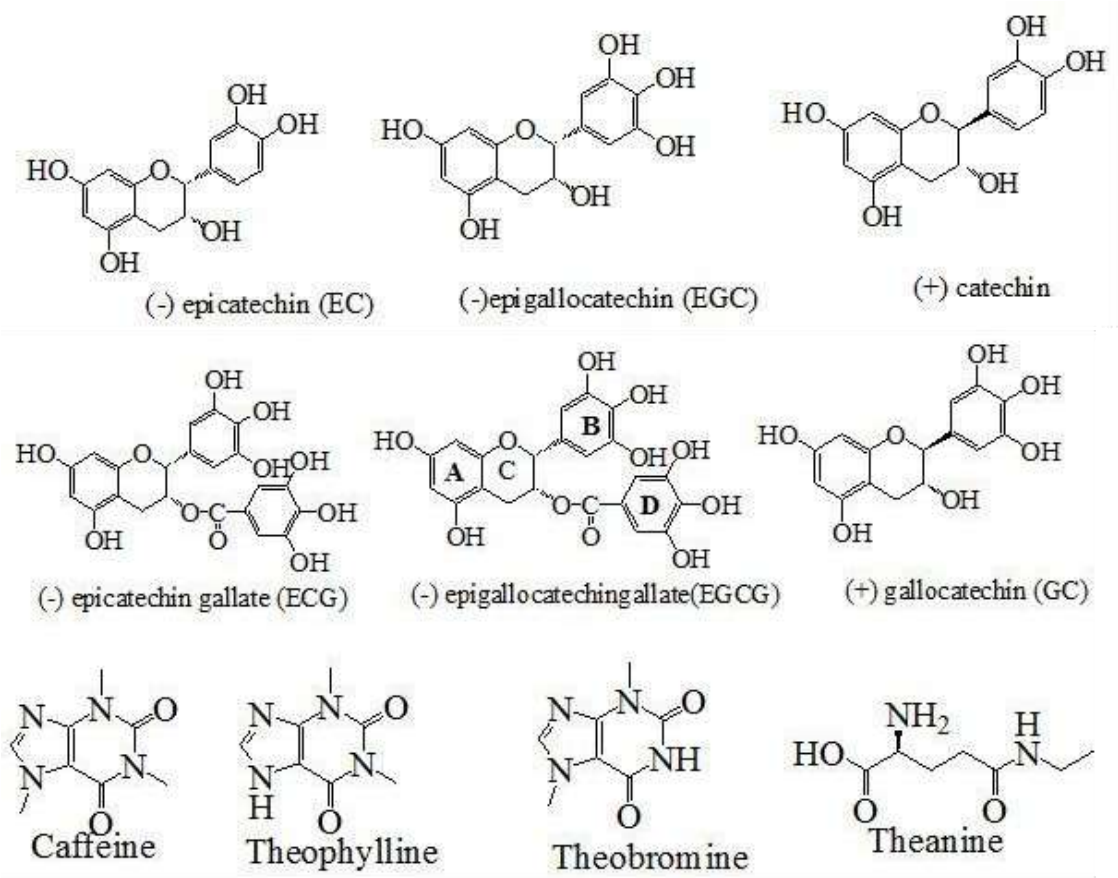

Fig5: Composition of antioxidant compounds

EGCG shown in fig., includes a benzenediol ring (labeled A) joined to a tetrahydropyran moiety (C), a pyrogallol ring (B) and a galloyl group (with the D ring). one aromatic ring shows the presence of antioxidant and anti-inflammatory properties of the respective compound.

Conclusion :

Green tea is consumed throughout the world in various forms. The years of safe consumption of this beverage, supported by numerous studies showing health benefits, warrant a general recommendation to consume it regularly. This article demonstrates the benefits of green tea for its anti-inflammatory and antioxidant potential. It has been used to treat cardiovascular diseases, oral cavity diseases, cardiovascular uses and Parkinson's disease. There is also a wide range of uses for green tea in diabetes, exercise enhancement, inflammatory bowel disease and skin disorders. Most impressive are the well-controlled epidemiologic studies, aimed at altering the brain ageing process, which can serve as neuroprotective agents. Although the human clinical data is still limited, this article shows that green tea has its place in both the conventional and alternative medical communities

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